ROBO BUILDER

Intelligent Modular Robot

# wCK series

## User's Manual

Ver 1.05

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# 1 INTRODUCTION

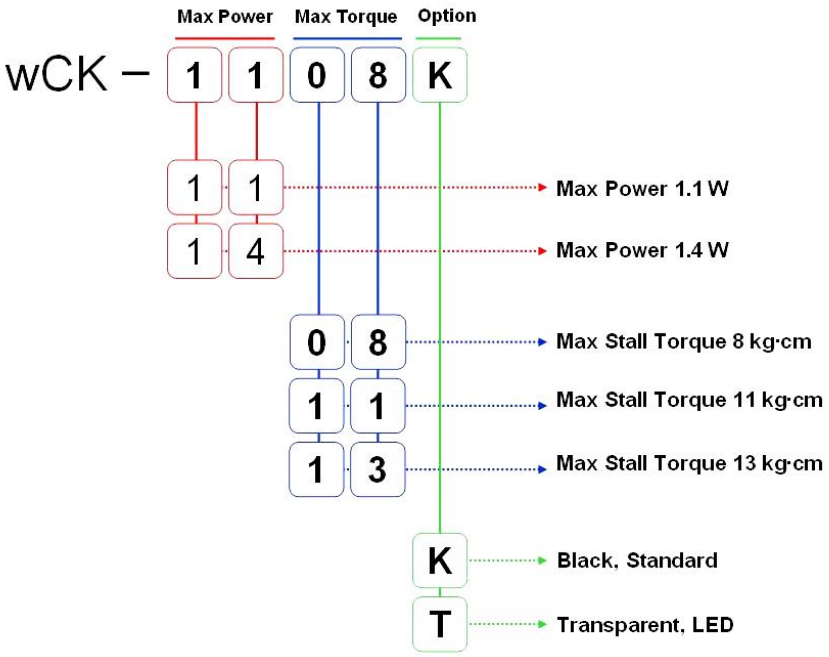
## 1-1 Introduction

RoboBuilder's wCK module is an intelligent robotic module with which users can build creative robots of various shapes and easily operate and control robots. It is the first block type robotic module in the world that has joint insert assembly structure. This quick and simple joint assembly scheme enables users to simply plug a plastic joint part into wCK modules to complete linking two different wCK modules mechanically, which helps reduce building time dramatically. Internally a control board and a servo actuator mechanism are integrated together inside the small plastic enclosure. wCK module itself can operates as a small independent robot system because it is equipped with external I/O ports and can run a self-running motion program. wCK module adopted PID motion control technology and realized motion control characteristics as precise and accurate as industrial servo motors. Users can design and build robotic systems with multi-axis articulated mechanism much more easily and efficiently by adopting wCK robotic module. It's because wCK module is designed for users to easily extend and do troubleshooting and maintenance.

[Figure 1-1a] Picture of wCK module(packaged)

[Figure 1-1b] Picture of wCK module

## 1-2 Model Listing




[Figure 1-2a] Model Name Scheme

• The series name "wCK" comes from the sound "Wingchick" that the actuator module makes when in motion.

| Model Listing | 0 8 Torque 8kg·cm | 1 1 Torque 11kg·cm | 1 3 Torque 13kg·cm | |
|---|---|---|---|---|
| 1 1 Power 1.1 W | wCK-1108K | wCK-1111K | wCK-1113K | K Black |
| | wCK-1108T | wCK-1111T | wCK-1113T | T Trans parent |
| 1 4 Power 1.4 W | wCK-1408K | wCK-1411K | wCK-1413K | K Black |
| | wCK-1408T | wCK-1411T | wCK-1413T | T Trans Parent |

(Available Model Listings may change without notice)

[Figure 1-2b] Model Listings

## 1-3 Main Specifications

| | |
|---|---|
| • Communication | Multi drop Full Duplex UART serial communication |
| • Baud Rate | 4,800bps ~ 921,600bps(8 levels) |
| • Extension | Max 254 modules per channel(ID 0~253) |
| • Operating Voltage | 6VDC ~ 10VDC(7.4VDC~8.4VDC recommended) |
| • Speed | Max No Load Speed 0.15 sec/60˚(wCK-1108 under recommended voltage) |
| • Stall Torque | Max 13kg·cm(wCK-1413 under recommended voltage) |
| • Max Power | 1.1W(wCK-1108, 1111), 1.4W(wCK-1413) |
| • Gear Ratio | 1/173(wCK-1108), 1/241(wCK-1111, 1413) |
| • Control Mode | Position Control, Speed Control, Torque Control |
| • Control Angle | 0~254(Standard Resolution), 0~1,022(High Resolution) |
| • Operating Angle | 0˚~269˚(Standard Resolution), 0˚~333˚(High Resolution) |
| • Resolution | 8 bit/1.055˚(Standard Rosolution), 10 bit/0.325˚(High Resolution) |
| • Error Range | ±0.8˚(Standard Resolution) |
| • Speed Level | 30 levels(Position Control Mode), 16 levels(Wheel Mode) |
| • Case Material | Engineering Plastic |
| • Gear Material | POM(wCK-1108), POM+Metal(wCK-1111,1413) |
| • Size | 51.6 mm×27.1 mm×36.4 mm |
| • Weight | 45g(wCK-1108), 49g(wCK-1111,1413) |

## 1-4 Main Features

**• All-in-One Integrated Robot Module**

All components such as controller, sensor, actuator, I/O port are integrated in a small plastic enclosure.

**• Compact Design**

Compact and fancy exterior design with smooth curved lines enhances its functionality as well as helps efficient mechanical system designing.

**• 2 Way Mechanical Power Transmission**

2 way mechanical power transmission structure enables users to build various structures of mechanical systems.

**• Quick & Simple Joint Assembly**

Quick and simple joint assembly scheme enables users to simply plug a plastic joint into wCK modules to complete linking wCK modules, which helps invent creative robots and reduce building time dramatically.

**• Presice PID Control**

Position control error of ±0.8˚ realized through precise PID control(in Standard Resolution)
High resolution Mode 10 bit 1,024 steps(unit control angle 0.325˚),
Standard Resolution Mode 8 bit 256steps(unit control angle 1.055˚)

- **Error Compensation Algorithm**

Special algorithm for position error compensation realized ±0.8˚ level of error with low resolution potentiometer feedback.

- **Position Control, Speed Control, Torque Control**

Three different control modes help users apply wCK module to systems with various control requirements.

- **Various Operation Mode**

Position control mode, Synchronized position control mode, Wheel mode, Passive mode, Break mode, Self-running mode, etc

- **Various Parameters**

Various parameters configurable such as wCK ID, Baud rate, Position control resolution, PID gains, Movement speed, Acceleration range, Motion Boundary, Max operation current, etc

- **Multi Drop Full Duplex UART serial communication**

The Full Duplex UART two-way serial communication enables to connect to wCK directly without using separate communication device from external controller.

- **Control Optimized Protocol**

Minimized communication time delay by adopting optimized protocol structure and real-time response method for all commands.

- **External I/O Port**

1channel A/D input(0V~5V), 2channels Digital Output(TTLlevel)

- **Self-running Motion**

wCK can run a motion and sensor interaction by itself without being controlled by external controller

- **Various Speed Levels**

30 levels in position control mode, 16 levels in 360˚ wheel mode

- **Voltage-adaptive Automatic Adjustment of Control Angle**

wCK module can implement automatic compensation for control output according to real-time input voltage

- **Windows based Programming Software**

Windows-based software such as wCK programmer, Motion Builder, Action Builder

- **Wide range of Input Voltage**

Wide range of input voltage (6VDC~10VDC)

- **Wide range of Control Angle**

0˚~269˚ in standard resolution, 0˚~333˚ in high resolution

- **Power-saving Break Mode**

Break mode stops the motion of a wCK module and thus help hold still system's mechanical structure without consuming electric power by using dynamic break effect.

- **Passive Sensor Mode**

In passive mode, wCK release torque and acts as a sensor

- **Reverse-voltage Protection, Over-current Protection**

Protection circuits built-in for reverse-voltage and over-current

- **Initialization of ID and Baud Rate**

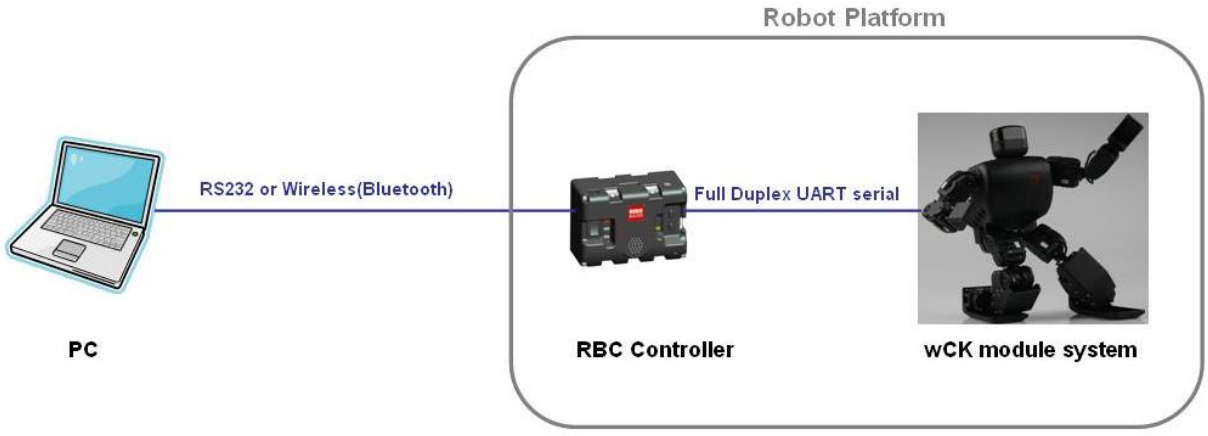
wCK ID and baud rate can be initialized for debugging or troubleshooting purpose

- **Two Metal Bearings for Mechanical Durability**

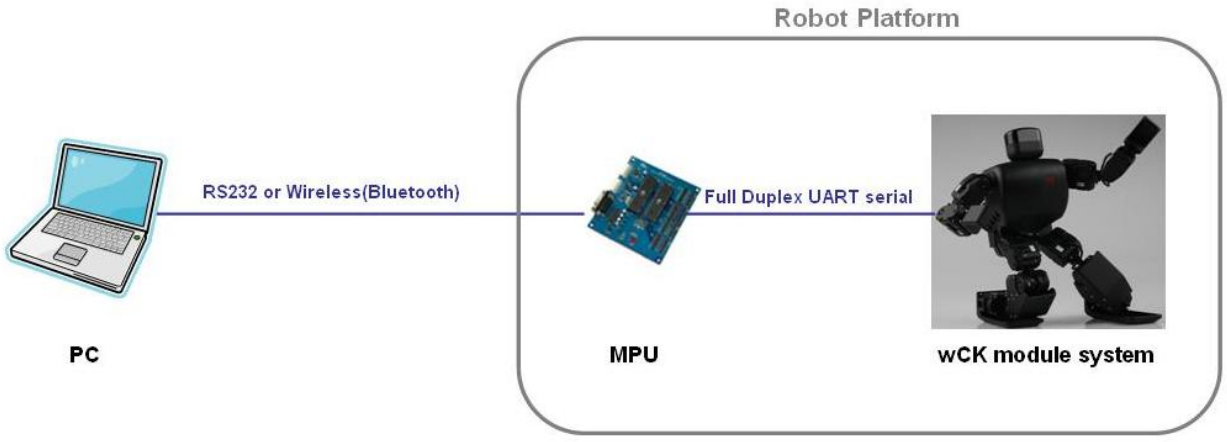
Mechanical durability is ensured with two metal bearings applied on rotation axis

## 1-5 Control Scheme

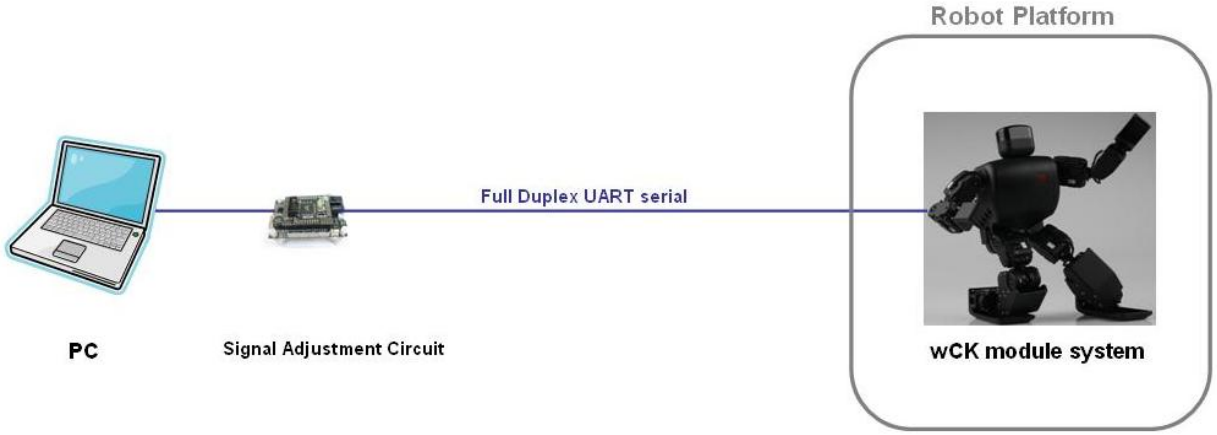
wCK module can be controlled by RoboBuilder's RBC controller, general puupose MCUs, as well as directly by a PC. In case of using RBC controller wCK module can be directly plugged onto the connectors of RBC controller because wCK module has signal adjusting circuit built-in and adjust signal levels between PC(RS-232 signal level) and wCK module(TTL signal level). A separate signal regulating circuit may be required when using a MCU or a PC to control wCK module. RoboBuilder provides separately this signal adjustment circuit board (refer to Appendix A-2 for detail).




[Figure 1-5a ] Using RBC controller




[Figure 1-5b ] Using general-purpose MCU



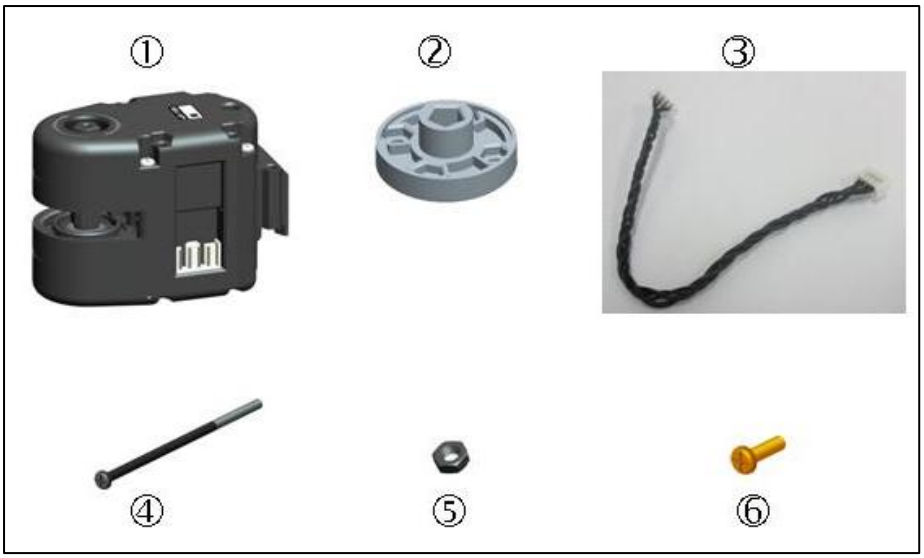

[Figure 1-5c ] Direct PC Control without external controller

## 1-6 Application

wCK module is applied to various types of articulated robot platforms for the purposes such as R&D, toy and entertainment, game and amusement, commercial, and educational purposes. It can also be used for systems that require multi-axis movement such as medical devices, tool set for science and education etc. The self-running motion of wCK module help build a simple and compact stand alone system too.

[Figure 1-6a] Application(Various Articulated Robots)

## 1-7 Part List




[Figure 1-7a] Part List

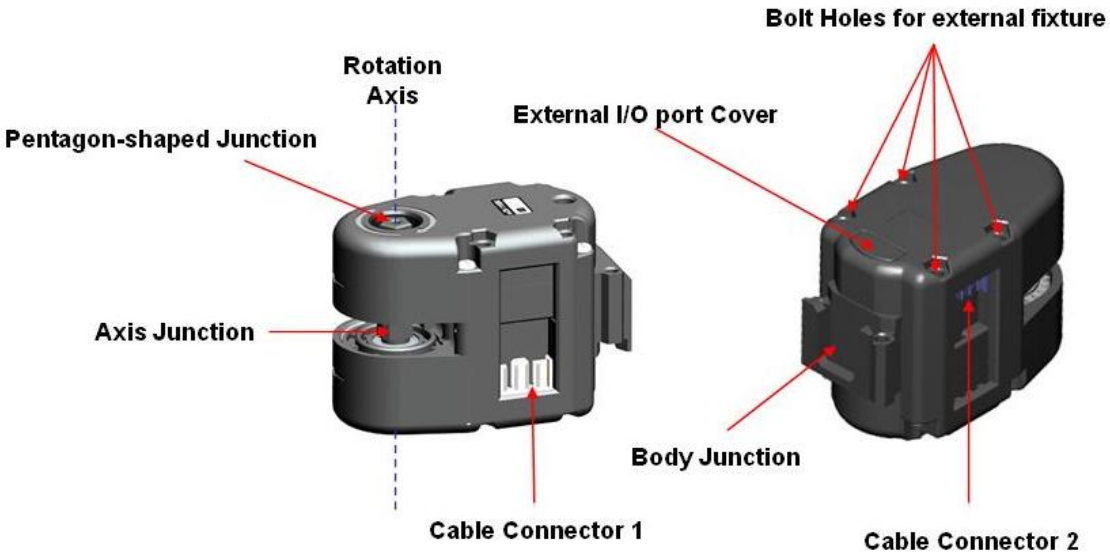
Part List

| No | Qty | | Part Name | Use |
|---|---|---|---|---|
| ① | 1 EA | × | wCK module | Intelligent wCK robot module |
| ② | 1 EA | × | Round Joint | Transmit force of wCK module to external object |
| ③ | 1 EA | × | wCK Cable (4wire twisted) | Wiring cable for wCK module |
| ④ | 4 EA | × | Bolt 1 (M2×40mm) | Fix wCK module onto external object |
| ⑤ | 4 EA | × | Nut (M2) | Fix wCK module onto external object |
| ⑥ | 1 EA | × | Bolt 2 (M2×8mm) | Fix round joint to the axis of wCK module |

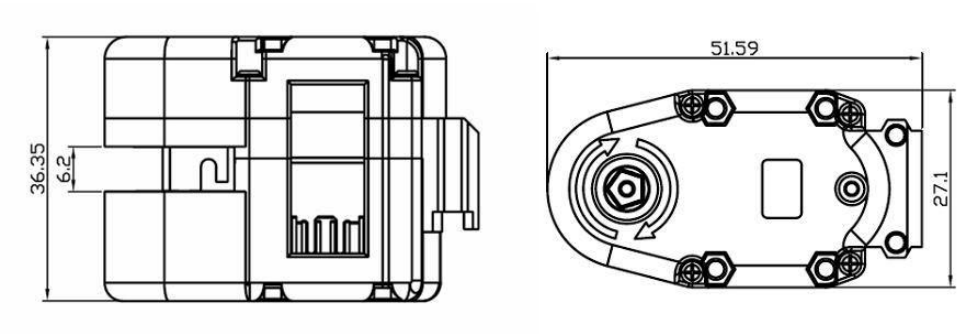
## 1-8 Mechanical Specifications

| | |
|---|---|
| • Size | 51.6 mm×27.1 mm×36.4 mm |
| • Weight | 45g(wCK-1108), 49g(wCK-1111,1413) |
| • Stall Torque | Max 13kg·cm(wCK-1413 under recommended input voltage) |
| • Mechanical Connection Method | Quick & Simple Joint Insert Assembly |
| • Mechanical Connection Point | 3 Junction Points(pentagon-shaped Junction, Axis Junction, Body Junction) |
| • Joint | Various Robot Structure can be created using 12 types connection Joints |
| • Gear Ratio | 1/173(wCK-1108), 1/241(wCK-1111, 1413) |
| • Gear Material | POM(wCK-1108), POM+Metal(wCK-1111,1413) |
| • Case Material | Engineering Plastic |
| • Case Color | Black(wCK-1108K, 1111K, 1413K), Transparent(wCK-1108T) |

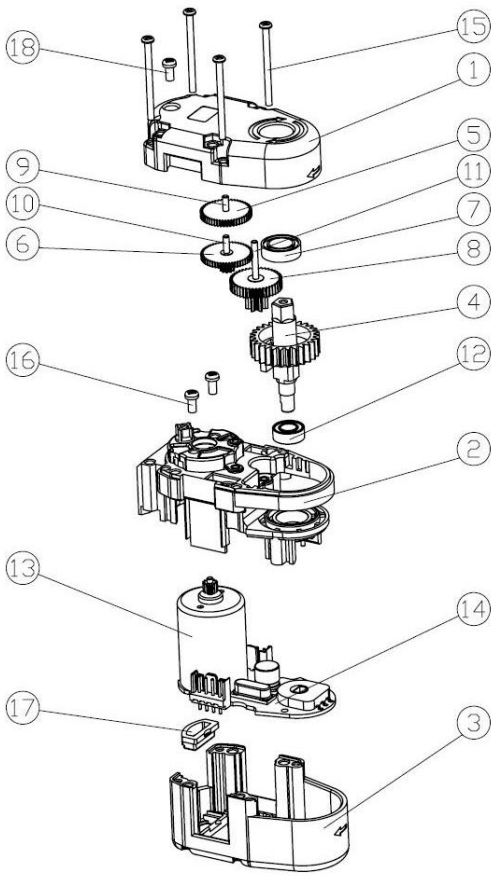
►cf. Max Stall Torque = Stall Torque of built-in DC motor × Gear Ratio× 80%




[Figure 1-8a] Names of External Parts




[Figure 1-8b] Dimension




1 Cover Top
2 Housing
3 Cover Bottom
4 Gear4
5 Gear1
6 Gear2
7 Bearing1
8 Gear3
9 Gear1 Shaft
10 Gear2 Shaft
11 Gear3 Shaft
12 Bearing2
13 DC Motor
14 PCB Ass'y
15 Screw1
16 Screw2
17 Ext I/O Cover
18 Screw3

[Figure1-8c] Blow Up Picture

### 1-9 Electrical & Control Specifications

| | |
|---|---|
| • Communication | Multi drop Full Duplex UART serial communication |
| • Baud Rate | 4,800bps ~ 921,600bps(8 levels) |
| • Extension | Max 254 modules per channel(ID 0~253) |
| • DC motor type | Precious metal brush DC motor |
| • Operation Voltage | 6VDC ~ 10VDC(7.4VDC~8.4VDC recommended) |
| • Max Current | 400mA ~ 1,800mA (Over-current Protection) |
| • Reverse-voltage Protection | 0 ~ -28V |
| • Max Power | 1.4W(wCK-1413), 1.1W(wCK-1108, 1111) |
| • Speed Level | 30 levels(Position Control Mode), 16 levels(Wheel Mode) |
| • Speed | Max No Load Speed0.19sec/60˚(wCK-1413), 0.21sec/60˚(wCK-1111), 0.15sec/60˚(wCK-1108) |
| • Acceleration Range | range from 20 to 100 |
| • Max Stall Torque | 13kg·cm(wCK-1413), 11kg·cm(wCK-1111), 8kg·cm(wCK-1108) under recommended input voltage |
| • Control Mode | Position Control, Speed Control, Torque Control |
| • Control Angle | 0~254(Standard Resolution), 0~1,022(High Resolution) |
| • Operation Angle | 0˚~269˚(Standard Resolution), 0˚~333˚(High Resolution) |
| • Resolution | 8 bit/1.055˚(Standard Resolution), 10 bit/0.325˚(High Resolution) |
| • Unit Control Angle | 269˚/255=1.055˚ (Standard Resolution), 333˚/1023=0.325˚ (High Resolution) |
| • Control Error | ±0.8˚(8 bit Standard Resolution) |
| • P gain | 1~120 recommended |
| • D gain | 0~254 recommended |
| • I gain | 0~10 recommended |

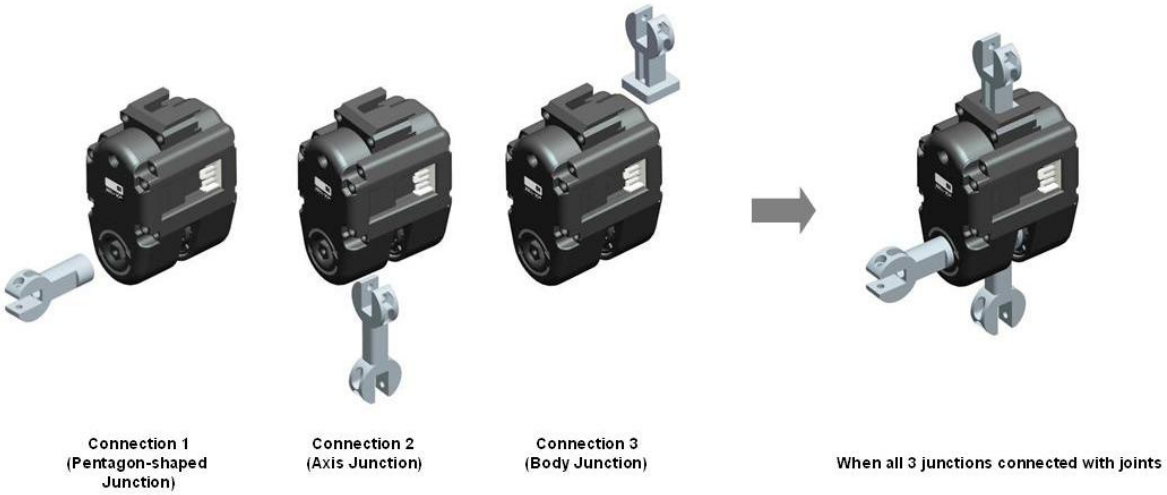
►cf. Max Power = Max Power of built-in DC motor × Gear Ratio × 66%(the average efficiency of 4-step mechanical gear)

►cf. Max No Load Speed = Max No Load Speed of built-in DC motor × 1 / Gear Ratio

# 2 USING wCK MODULE

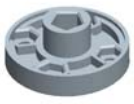
### 2-1 Mechanical Connection

wCK modules can be easily connected and extended by plugging various joint parts into the junction points of wCK module. This Quick & Simple assembly scheme enables users to design and build robot systems with various and complex articulated structure quickly and efficiently.




[Figure 2-1a] Joint Connection Scheme

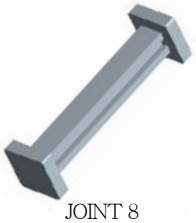
A variety of mechanical structures are available using the joints shown below in [Figure 2-1b]. When connecting a joint with wCK module the junction is held tight even without screwing bolts, which is very effective and helpful for users to invent creative structures in designing a new robotic system.

| | | | | |
|---|---|---|---|---|
| | | | | |
| JOINT 1 | JOINT 2 | JOINT 3 | JOINT 4 | JOINT 5 |
| | | | | |
| JOINT 6 | JOINT 7 | JOINT 8 | JOINT 9 | JOINT 10 |
| |  | | | |
| JOINT 11 | JOINT 12 | | | |

*(Joint sold separately as option)*

[Figure 2-1b] Joint Type

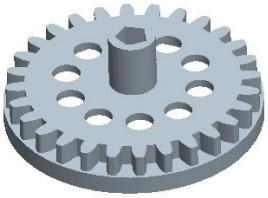
Joints are grouped as below according to different points of connecting junction.

| Junction Point | JOINT |
|---|---|
| Pentagon-shaped Junction + Axis Junction | JOINT 2 |
| Pentagon-shaped Junction + Body Junction | JOINT 3 |
| Axis Junction + Body Junction | JOINT 1 JOINT 6 |
| Body Junction + Body Junction | JOINT 4  JOINT 8 |
| Axis Junction + Axis Junction | JOINT 10 |
| Others | JOINT 5 JOINT 7 JOINT 9 JOINT 11 JOINT 12 |

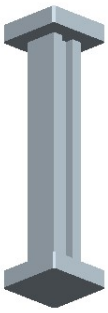
[Figure 2-1c] Joint Type for Different Connection

[Figure 2-1d] Joint Type for Connection Styles

| | |
|---|---|
| JOINT 1 | |
| JOINT 2 | |
| JOINT 3 | |

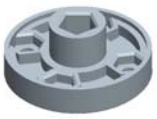
<table>
<tr><td rowspan="2"> <br>JOINT 4</td><td> </td></tr>
<tr><td> </td></tr>
<tr><td>  <br>JOINT 5</td><td> </td></tr>
<tr><td rowspan="2"> <br>JOINT 6</td><td> </td></tr>
<tr><td> </td></tr>
</table>

JOINT 7



JOINT 8

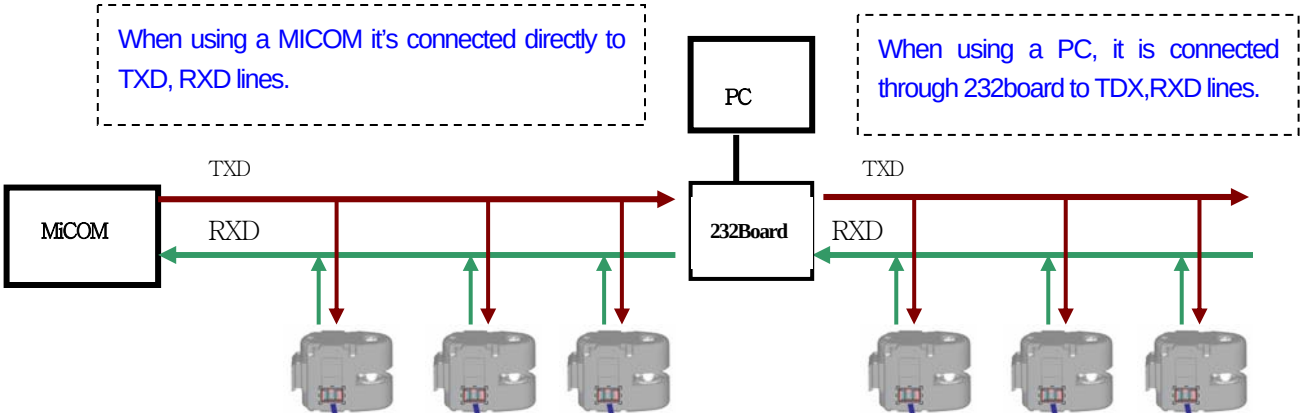
JOINT 9

| | |
|---|---|
| JOINT 10 | |
| JOINT 11 | |
|  JOINT 12 | |

## 2-2 Electrical Connection

**Wiring**

Depending on controller type the electrical wiring structure is different as shown in below [Figure 2-1a] and [Figure 2-2b].




[Figure 2-2a] Using a MICOM

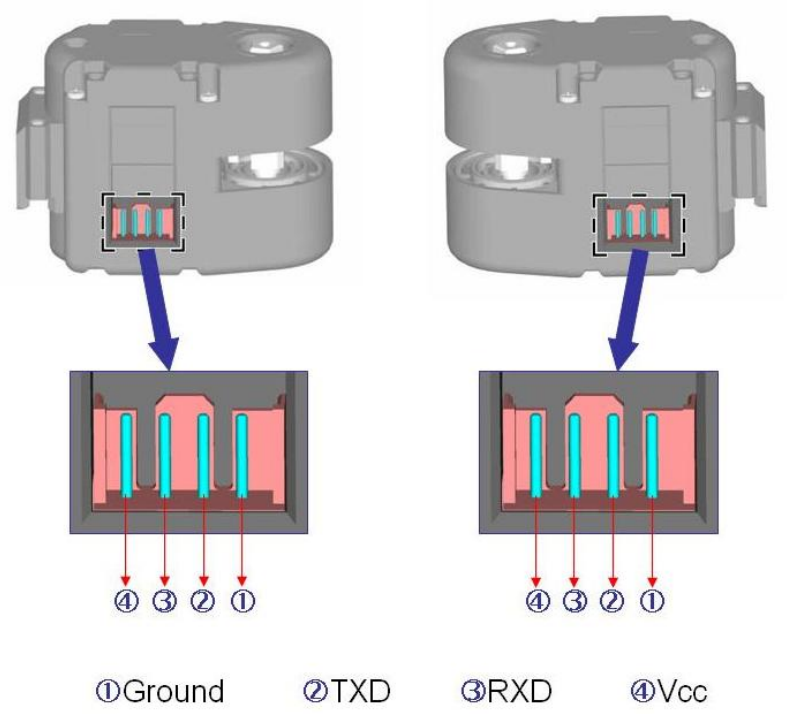
[Figure 2-2b] Using a PC

[Figure 2-2c] wCK module cable

[Figure 2-2d] PC Connection Cable

**Connectors**

wCK module has two built-in connectors on both sides of the body. The two connectors are electrically connected in parallel internally so the module is ready to communicate if either one of the two connectors are plugged. The other one is used to extend to another wCK module. The connectors at both ends of a wCK module cable are designed specially so that they can't be plugged turned inside out, which eliminates the risk of making a wiring mistake.

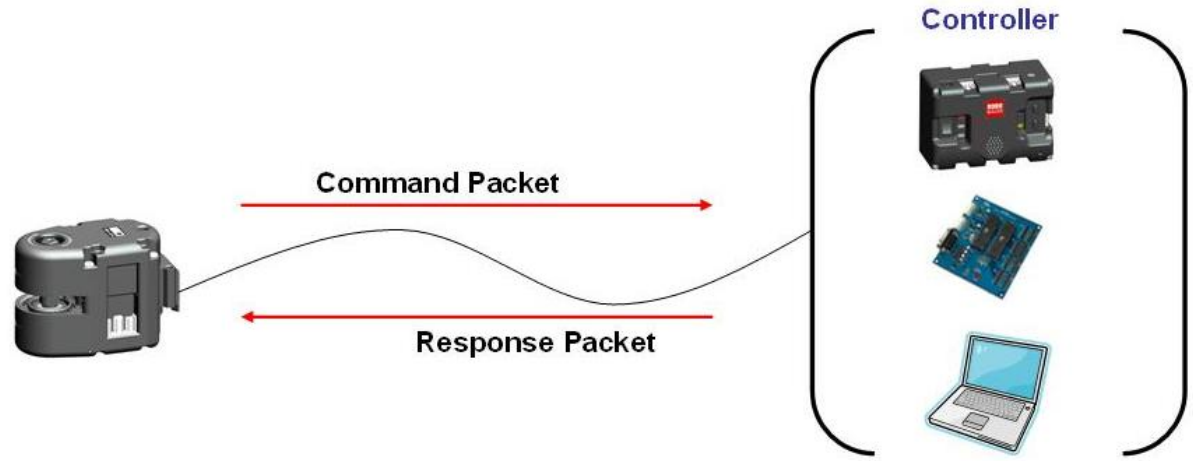



[Figure 2-2e] wCK module Cable Connector & Pin Arrangement

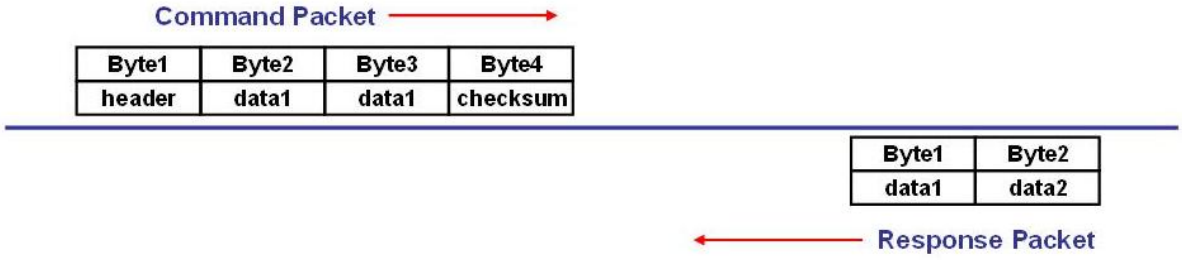
## 2-3 Communication

**Protocol**

wCK module adopted a dedicated special communication protocol named "Multi drop Full Duplex UART two-way serial communication protocol". Basically the communication is carried out in a repeated cycle of that Controller sends Command Packet to wCK module and then wCK module sends back Response Packet in return.




[Figure 2-3a] Communication




[Figure 2-3b] Protocol Structure

**Summary of Protocol Commands**

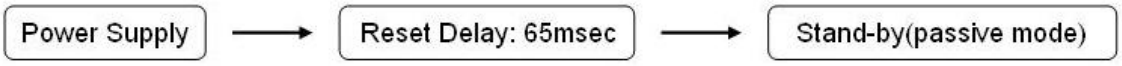
Below is the summary of protocol commands required to control a wCK module.

For detailed explanation of protocol commands, please refer to appendix [A-1Communication Protocol].

| | | |
|---|---|---|
| **8 bit Command** | (1) Position Move | Move Position Command |
| | (2) Synchronized Position Move | Synchronized Move Position Command(used to control multiple wCK modules) |
| | (3) Status Read | Read Torque and Position |
| | (4) Passive wCK | Passive Mode(Sensor Mode) Command |
| | (5) Wheel wCK | 360˚ Wheel Mode Command |
| | (6) Break wCK | Break Mode(Power-saving) Command |
| **Set Command** | (7) Baud rate Set | Baud rate Setting Command |
| | (8) P,D gain Set | P gain, D gain Setting Command |
| | (9) P,D gain Read | Read P gain and D gain |
| | (10) I gain Set | I gain Setting Command |
| | (11) I gain Read | Read I gain |
| | (12) Runtime P,D gain Set | Runtime P gain, D gain Setting Command |
| | (13) Runtime I gain Set | Runtime I gain Setting Command |
| | (14) ID Set | wCK ID Setting Command |
| | (15) Speed Set | Speed/Acceleration range Setting Command |
| | (16) Speed Read | Read Speed/Acceleration range |
| | (17) Runtime Speed Set | Runtime Speed/Acceleration range Setting Command |
| | (18) Over Load Set | Over Load Setting Command |
| | (19) Over Load Read | Read Over Load |
| | (20) Boundary Set | Movement Boundary Setting Command |
| | (21) Boundary Read | Read Movement Boundary Setting Command |
| **Extended Command** | (22) I/O Write | Write to External I/O port |
| | (23) I/O Read | Read External I/O port |
| | (24) Motion Data Write | Write Self-running motion program |
| | (25) Motion Data Read | Read Self-running motion program |
| **10 bit Command** | (26) Position Move | 10 bit Move Position Command |
| | (27) Position Read | 10 bit Read Position Command |

**Reset Time after Power Supply**

wCK module turns into "Stand By" status after 65msec during which no command is recognized.




**Communication Time Delay**

Command transmission through RS-232 inevitably generate time delay if multiple wCK modules are connected together. So each wCK module receive command in different time. Usually this time delay is ignorable but for a system that requires precise control characteristics please refer to below table and use it to design a system accordingly.

| Baud Rate [bps] | 1 Byte Transmission Time [$\mu$s] | 1 Command(4 byte) Transmission Time [$\mu$s] | 1 Command Delay Time at 30 rpm [°] |
|---|---|---|---|
| 4,800 | 2.083 | 8.333 | 1.5 |
| 9,600 | 1.042 | 4.167 | 0.75 |
| 38,400 | 0.260 | 1.042 | 0.1875 |
| 57,600 | 0.174 | 0.692 | 0.0125 |
| 115,200 | 0.087 | 0.347 | 0.0625 |
| 230,400 | 0.043 | 0.174 | 0.03125 |
| 460,800 | 0.022 | 0.087 | 0.015625 |
| 921,600 | 0.011 | 0.043 | 0.0078125 |

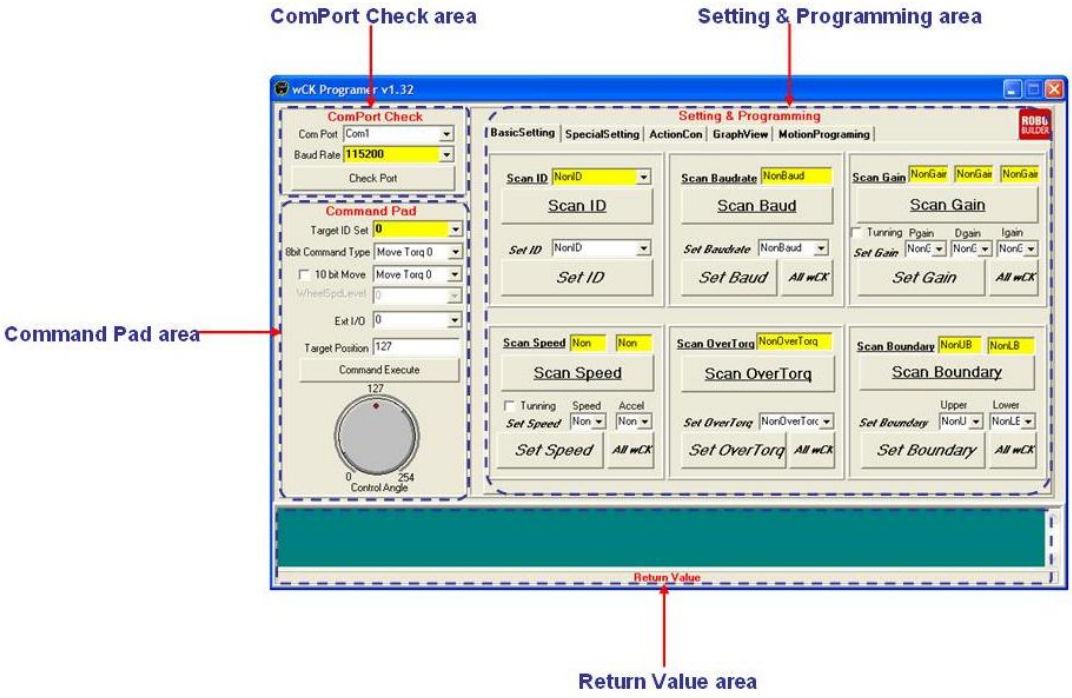
**Command Response Time**

Below table shows the Command Response Time at different baud rates. Command Response Time means the amount of time which takes for a wCK module from sending a Command Packet to receiving its Response Packet.

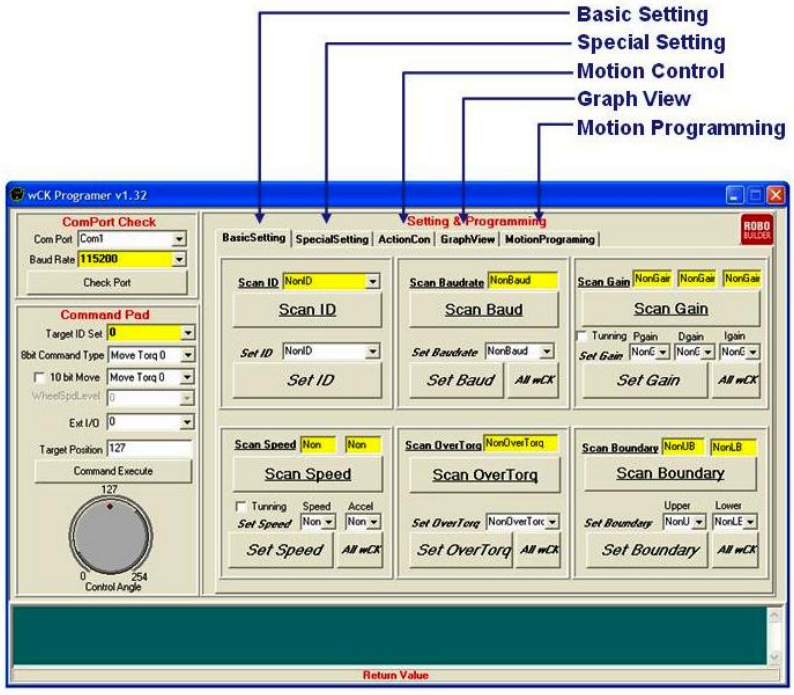
| Command \ Baud Rate | 4800 bps | 9600 bps | 38400 bps | 57600 bps | 115200 bps |
|---|---|---|---|---|---|
| Position Move | 13159 | 7083 | 2517 | 1354 | 1180 |
| Position Read | 13159 | 7083 | 2517 | 1354 | 1180 |
| Passive wCK | 13159 | 7083 | 2517 | 1354 | 1180 |
| Break wCK | 13159 | 7083 | 2517 | 1354 | 1180 |
| Wheel wCK | 13159 | 7083 | 2517 | 1354 | 1180 |
| Read Gain | 17326 | 9166 | 3038 | 1701 | 1354 |
| Read Resolution | 17326 | 9166 | 3038 | 1701 | 1354 |
| Read Load Range | 17326 | 9166 | 3038 | 1701 | 1354 |
| Read Boundary | 17326 | 9166 | 3038 | 1701 | 1354 |
| Baud Rate Set | 136144 | 127950 | 122829 | 121492 | 121145 |
| Gain Set | 136144 | 127950 | 122829 | 121492 | 121145 |
| ID Set | 136144 | 127950 | 122829 | 121492 | 121145 |
| Resolution Set | 136144 | 127950 | 122829 | 121492 | 121145 |
| Load Range Set | 136144 | 127950 | 122829 | 121492 | 121145 |
| Boundary Set | 136144 | 127950 | 122829 | 121492 | 121145 |

## 2-4 Software

Users need to use "wCK programmer" the developer's software tool in order to use and control a wCK module. Windows-based wCK programmer is used to configure all settings and parameters, execute and simulate commands, create and edit self-running motion program. Refer to separate user's guide to understand the details about wCK programmer.




[Figure 2-4a] wCK Programmer Screen Layout

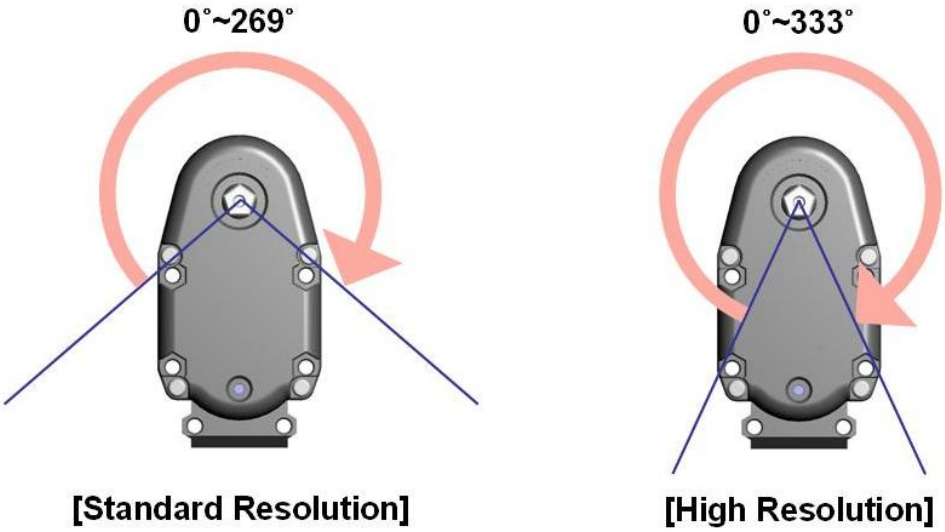



[Figure 2-4b] Setting & Programming Area

# 3 CONTROL FUNCTIONS

## 3-1 Position Control

The Position Control of wCK module is a function that a user ask wCK module to go to a specific position(target position in the unit of control angle) then the wCK module moves to that specific position to complete the command. The actual physical displacement is different from control angle depending on the control resolution in which wCK operates.

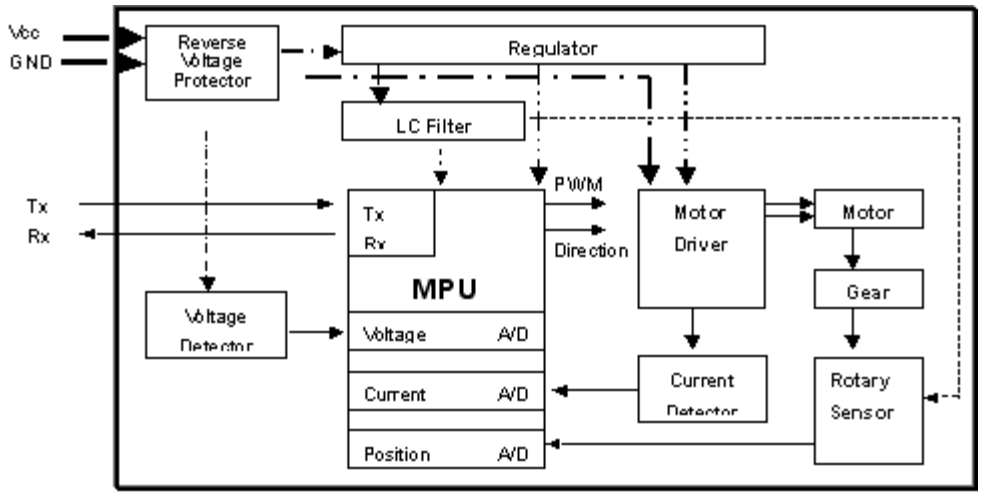



Control Angle is a conceptual angle that controller use to calculate and control internally, while Movement Angle means the actual displacement of angle that a wCK module makes to move to a target position angle. Unit Angle is the physical displacement of rotation angle caused by executing a single unit of Control Angle.

| | |
|---|---|
| Control Angle | 0~254(Standard Resolution), 0~1,022(High Resolution) |
| Movement Angle | 0°~269°( Standard Resolution), 0°~333°( High Resolution) |
| Unit Angle | 269°/255=1.055° (Standard Resolution), 333°/1023=0.325° (High Resolution) |
| Control Error | ±0.8°( Standard Resolution) |

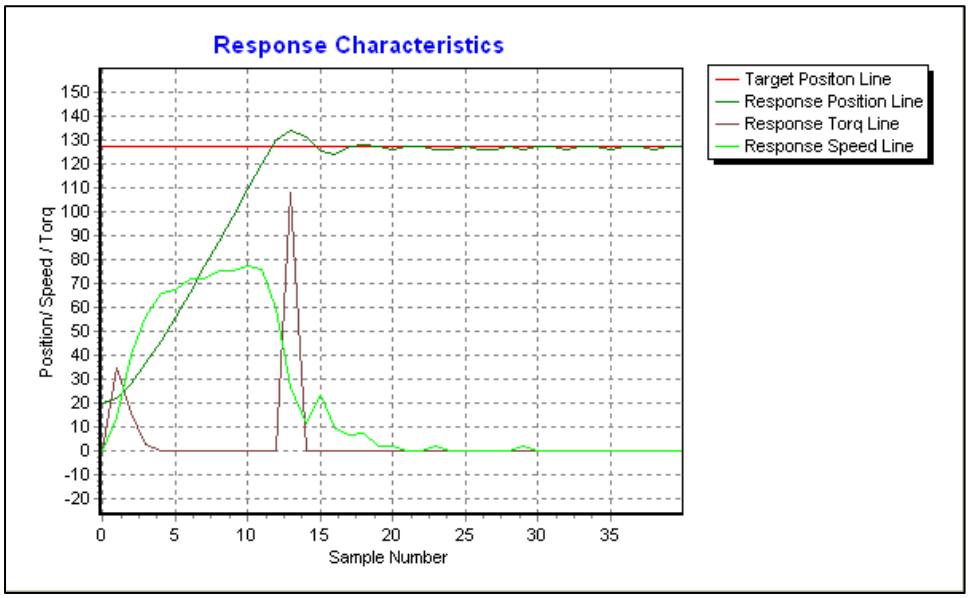
The full Movement Angle above can be used when a Joint such as Joint 2, Joint 3, Joint 5, Joint 9, Joint 12 is connected to the Pentagon-shaped Junction, while a smaller range of Movement Angle is available when a Joint such as Joint 1, Joint 2, Joint 6, Joint 10 is connected to the Axis Junction.

wCK module realized precise motion control by adopting PID control technology. The following is the block diagram that shows the simplified control scheme of the built-in motion control system.

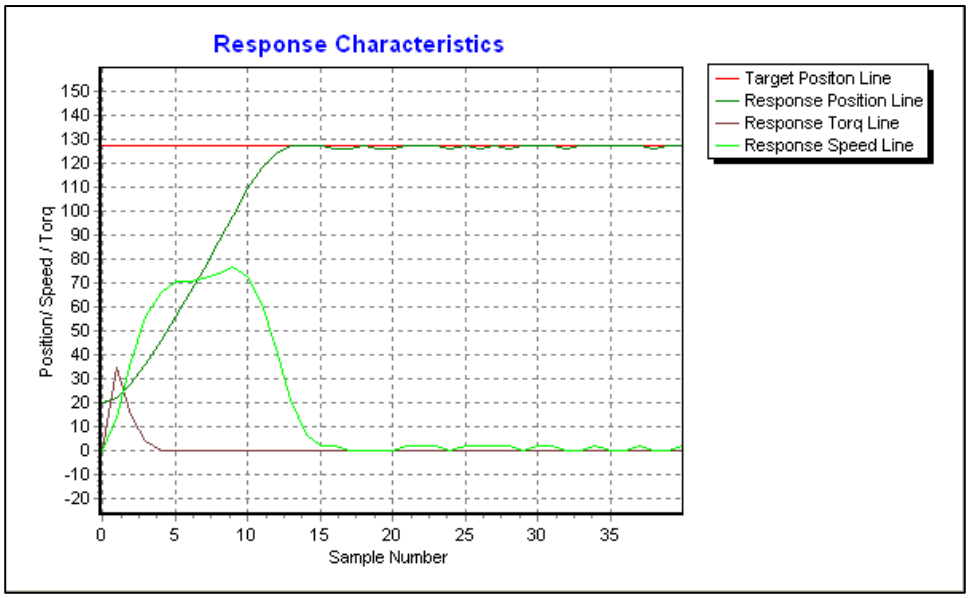



Below are the response characteristics graphs that show the different response characteristics of wCK module when each method of P gain Control, PD gain Control, and PID gain Control is applied.

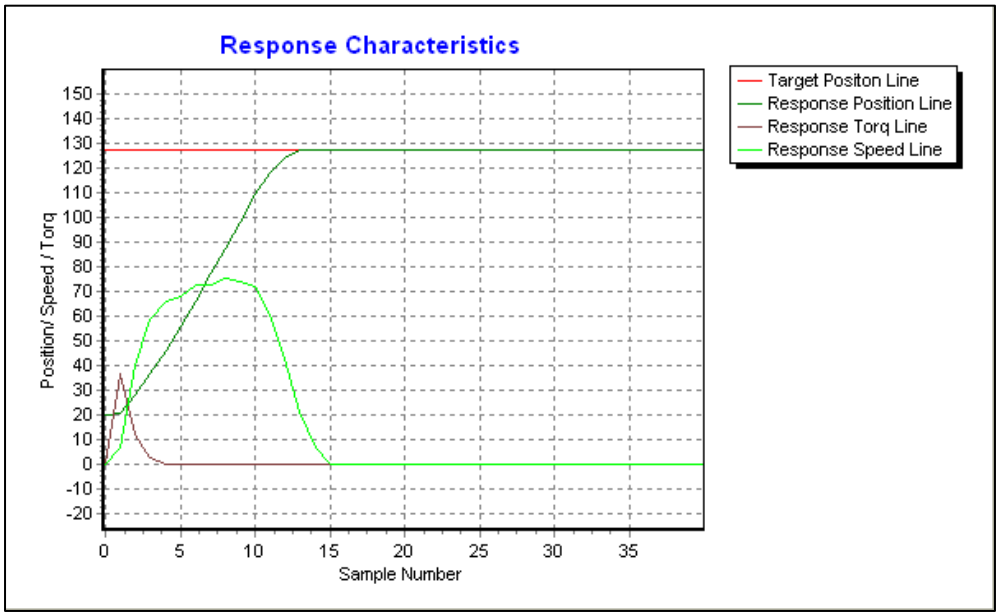
- P gain Control



- PD gain Control




- PID gain Control



## 3-2 Synchronized Position Control

Synchronized Position Control function is used to synchronize and control multiple wCK modules that are connected electrically on a same channel. Maximum 31 wCK modules can be connected and controlled simultaneously so this function is very useful in motion controlling a multi-axis robotic systems.

## 3-3 Passive Mode

Passive wCK Mode is used to release the torque out of the axis of the wCK module and so that the rotation axis is moved smoothly by external force, which means wCK module play the role of a sensor.

## 3-4 Speed/Acceleration Setting

User can select and change the levels of speed(from 0 to 30) and acceleration range(from 20 to 100) of a wCK module.

## 3-5 Movement Boundary Setting

User can set the movement boundary range of a wCK so that wCK can move only within the specified range of rotation angle. This function is useful for applications that requires a motion in a narrow range of movement angle is critical.

## 3-6 Reverse-voltage Protection

wCK module has reverse-voltage protection circuit built-in inside to protect from user's wiring mistake.

## 3-7 Over-current Protection

wCK module has over-current(over-torque) protection circuit built-in inside to protect product from excessive external force and protect user from injury. A range of from 33 to 199 is selectable for actual scale of current from 400 mA to 1,800 mA.

## 3-8 Wheel Mode

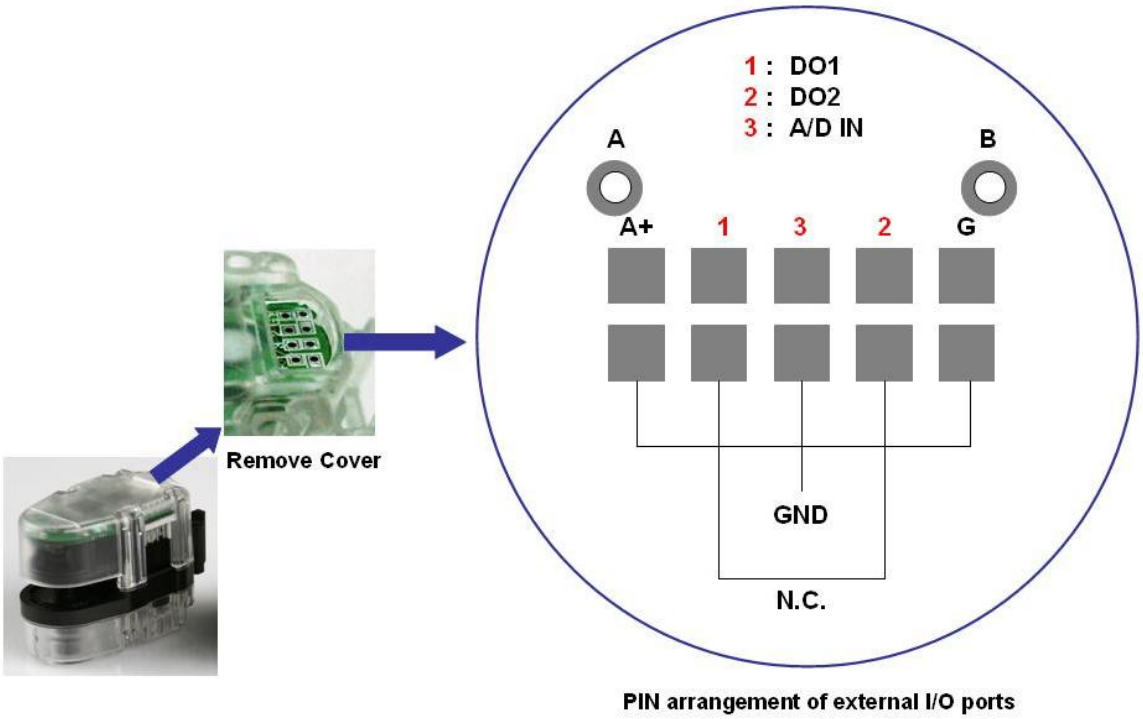
Using wCK module's 360˚ Wheel Mode a user can build a system that requires a spinning motion at a specified rotation speed. Spinning in either clock-wise direction and counter clock-wise direction is selectable and 16 levels of speed can be set up.

## 3-9 Break Mode

Break Mode stops the motion of a wCK module and thus help hold still a system's mechanical structure without consuming electric power by using dynamic break effect. Once break mode applied, all wCK modules connected on a single channel turn into Break Mode.

## 3-10 External I/O Port

wCK module has 1 channel of A/D input(0V~5V) and 2 channels of Digital Output(TTL level).




[Figure 3-10] External I/O Port & Pin Arrangement

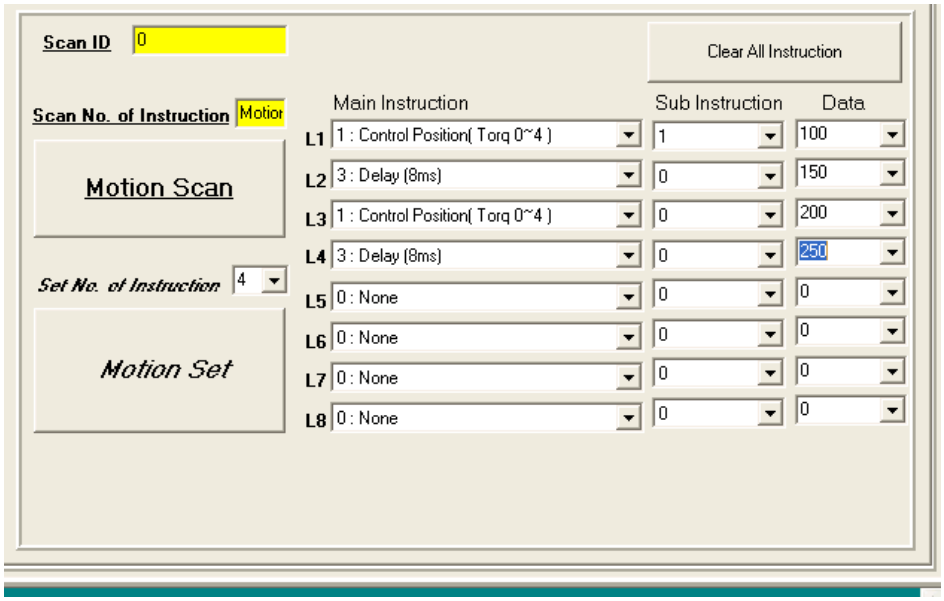
## 3-11 Self-running Motion

wCK module's self-running motion enables users to build a simple and compact stand alone system without using a separate external controller. The programming logics used in the "wCK programmer" when creating a self-running motion is shown as in table below. Self-running motion is activated only when the No of Instruction is more than 0. Please refer to appendix [A-1-3 extended command (24) Motion Data Write] for its relationship with the structure of Command Packet.

| **Motion Command(1 Byte)** | | **Motion Data(1 Byte)** |
|---|---|---|
| **Main Instruction** | **Sub Instruction** | **Data** |
| 0: None | 0 | X |
| 1: Position Control | Speed(0~4) | 8 bit Position Value |
| 2: Motion Type | 1(Passive),<br>2(Power Down),<br>3(Wheel CCW),<br>4(Wheel CW) | The Speed value in Wheel Mode(0~15) |
| 3: Delay Time(Max 4,095 ms) | Upper 4 bit delay value | Lower 8 bit delay value(in ms) |
| 4: DIO | X | 2 bit external port output value |
| 5: Position Conditional Decision | 1("==")<br>2(">")<br>3("<")<br>4(">=")<br>5("<=") | 8 bit Position Value |
| 6: A/D Conditional Decision | 1("==")<br>2(">")<br>3("<")<br>4(">=")<br>5("<=") | 8 bit external port A/D input value |
| 7: No of Repetition | X | 0 : Infinity, 1 to 254(No of repetition) |
| 8: End of Program | X | X |

[Example Program]

The rotation axis of a wCK module moves to position 100 at torque 1, then moves to position 200 at torque 0 after delay 150, then repeat this motion after delay 250.




## 3-12 Initialization of wCK ID and Baud rate

While configuring or controlling a wCK module, user may encounter a problem or a situation when he has unavoidably to initialize the ID and baud rate of the wCK module by mistake or for product fault. Remove the cover of external I/O port first and use tweezers to apply electric current between point A and point B for more than 10 seconds, then the ID and baud rate get initialized.(default initial values, ID=0, Baud rate=115,200)

# A. APPENDIX

## A-1 Communication Protocol

### A-1-1 8 bit Command

(1) Position Move

"Position Move" command makes wCK module return the values of current load and current position to controller and then move to a specified target position.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|
| Header | Data1 | Target position | Checksum |

Header = 0xFF

Data1

| Torque | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Torq : 0(Max)~4(Min), ID : 0~30

Target position = 0~254

Checksum = (Data1 X OR Target position) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| Load | Position |

※ Load : 0~254, Position : 0~254

e.g.) Command a wCK module with ID 0 to move to target position 0x7F(127) at torque 0

• Command Packet

| 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|
| 0xFF | 0x00 | 0x7F | 0x7F |

• Response Packet

| 1byte | 1byte |
|---|---|
| Load | Position |

(2) Synchronized Position Move

"Synchronized Position Move" command makes multiple wCK modules move to a specified target position. Five torque levels are selectable for the movement.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | | 1byte | 1byte |
|---|---|---|---|---|---|---|
| Header | Data1 | Data2 | ID0 target | ··· | lastID target | Checksum |

Header = 0xFF

Data1

| Torque | | | 31 | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Torque : 0(Max)~4(Min)

Data2

| Arbitrary Value | | | lastID+1 | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Last ID + 1 : 1~31(last wCK module's ID+1)

※ ID[ x ] target : 0~254(target position of wCK module with ID x)

※ Last ID target : 0~254(target position of wCK module with Last ID)

Checksum = (ID0 target XOR …(byte(LAST ID +3)) AND 0x7F

▶ Response Packet None

e.g.) Command wCK modules with ID 0 and ID 1 to move simultaneously to target position 0x7F(127) at torque 0(Max)

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0x1F | 0x02 | 0x7F | 0x7F | 0x00 |

• Response Packet None

(3) Status Read

"Status Read" command makes wCK module read its current load and current position.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|
| Header | Data1 | Data2 | Checksum |

Header = 0xFF

Data1

| Mode(=5) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode: 5, ID : 0~30

Data2 = Arbitrary Value

Checksum = (Data1 XOR Data2) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| Load | Position |

※ Load : 0~254, Position : 0~254

e.g.)Command a wCK module with ID 0 to read its status.

• Command Packet

| 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|
| 0xFF | 0xA0 | 0x00 | 0x20 |

• Response Packet

| 1byte | 1byte |
|---|---|
| Load | Position |

(4) Passive wCK

"Passive wCK" command makes a wCK module return the value of current position and release torque from the rotation axis so that it can be moved freely by external force.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|
| Header | Data1 | Data2 | Checksum |

Header = 0xFF

Data1

| Mode(=6) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 6, ID : 0~30

Data2

| Mode(=1) | | | | Arbitrary Value | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 1

Checksum = (Data1 XOR Data2) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| Data2 | Position |

※ Position : 0~254

e.g.)Command a wCK module with ID 0 to turn into Passive wCK mode

• Command Packet

| 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|
| 0xFF | 0xC0 | 0x10 | 0x50 |

• Response Packet

| 1byte | 1byte |
|---|---|
| 0x10 | Position |

(5) Wheel wCK

"Wheel wCK" command makes a wCK module carry out 360° revolving motion. 16 different speed levels are selectable.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|
| Header | Data1 | Data2 | Checksum |

Header = 0xFF

Data1

| Mode(=6) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode: 6, ID : 0~30

Data2

| 회전방향 | | | | 속도 | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Direction : 3(CCW), 4(CW)

※ Speed : 0(stop), 1(min)~15(max)

Checksum = (Data1 XOR Data2) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| No of Rotation | Position |

※ No of Rotation : 0~255(No of Rotation after power supplied, :CCW, :CW)

※ Position = 0~254

e.g.) Command a wCK module with ID0 to revolve to CCW direction at speed level 15.

• Command Packet

| 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|
| 0xFF | 0xC0 | 0x3F | 0x7F |

• Response Packet

| 1byte | 1byte |
|---|---|
| 회전 수 | Position |

(6) Break wCK

"Break wCK" command make all wCK modules connected on one channel to turn into Break Mode. Break Mode stops the motion of a wCK module and thus help hold still a system's mechanical structure without consuming electric power by using dynamic break. In this mode, the rotation axis become stiff and hard to move with a hand.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|
| Header | Data1 | Data2 | Checksum |

Header = 0xFF

Data1

| Mode(=6) | | | 31 | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 6

Data2

| Mode(=2) | | | | Arbitrary Value | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 2

Checksum = (Data1 XOR Data2) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| ID | Position |

※ ID : 0~30, Position : 0~254

e.g.) Command a wCK module with ID 0 to turn into Break mode

• Command Packet

| 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|
| 0xFF | 0xDF | 0x20 | 0x7F |

• Response Packet

| 1byte | 1byte |
|---|---|
| 0x00 | Position |

### A-1-2 Set Command

(7) Baud rate Set

"Baud rate Set" command sets the communication baud rate of a wCK module. Supported baud rates are 4800 bps, 9600 bps, 38400 bps, 57600 bps, 115200 bps, 230400 bps, 460800 bps, 921600 bps.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x08

Data3 = 0(921600bps), 1(460800bps), 3(230400bps), 7(115200bps),
15(57600bps), 23(38400bps), 95(9600bps), 191(4800bps),

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| new Baud rate | new Baud rate |

※ new Baud rate : 0~191

e.g.) Set the baud rate of a wCK module with ID 0 to 115200bps.

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x08 | 0x03 | 0x03 | 0x68 |

• Response Packet

| 1byte | 1byte |
|---|---|
| 0x03 | 0x03 |

(8) P, D gain Set

"P,D gain Set" command sets the P gain and D gain of a wCK module. It's recommended that user set P gain and D gain according to the formula of P gain = 1.5 × D gain.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x09

Data3 = new P-gain (1~254 recommended)

Data4 = new D-gain (0~254 recommended)

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| new P gain | new D gain |

※ new P gain : 1~254, new D gain : 0~254

e.g.) Set the P gain and D gain of a wCK module with ID 0 (P gain = 100, D gain = 100).

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x09 | 0x64 | 0x64 | 0x69 |

• Response Packet

| 1byte | 1byte |
|---|---|
| 0x64 | 0x64 |

(9) P, D gain Read

"P, D gain Read" command makes a wCK module read the values of P gain and D gain.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x0A

Data3 = Arbitrary Value

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| P gain | D gain |

※ P gain : 1~254, D gain : 0~254

e.g.) Command a wCK module with ID 0 to read its P gain and D gain.

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x0A | 0x00 | 0x00 | 0x6A |

• Response Packet

| 1byte | 1byte |
|---|---|
| P-gain | D-gain |

(10) I gain Set

"I gain Set" command sets the I gain of a wCK module.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x15

Data3 = new I gain(0~10 recommended)

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| new I gain | new I gain |

※ new I gain : 0~10

e.g.) Set the I gain of a wCK module with ID 0 to 100.

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x15 | 0x64 | 0x64 | 0x75 |

• Response Packet

| 1byte | 1byte |
|---|---|
| 0x64 | 0x64 |

(11) I gain Read

"I gain Read" command makes a wCK module read the value of I gain.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x16

Data3 = Arbitrary Value

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| I-gain | I-gain |

※ I gain : 0~10

e.g.) Command a wCK module with ID 0 to read its I gain

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x16 | 0x00 | 0x00 | 0x76 |

• Response Packet

| 1byte | 1byte |
|---|---|
| I-gain | I-gain |

(12) Runtime P, D gain Set

"Runtime P, D gain Set" command set the runtime P gain and D gain of a wCK module. When power cycled, the gains return to their original values.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x0B

Data3 = 1~254 recommended (P-gain)

Data4 = 0~254 recommended (D-gain)

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| P gain | D gain |

※ P gain : 1~254, D gain : 0~254

e.g.) Set the runtime P gain and D gain of a wCK module with ID 0 (P gain = 100, D gain = 100).

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x0B | 0x64 | 0x64 | 0x69 |

• Response Packet

| 1byte | 1byte |
|---|---|
| 0x64 | 0x64 |

(13) Runtime I gain Set

"Runtime I gain Set" command set the runtime I gain of a wCK module. When power cycled, the gain returns to its original value.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x18

Data3 = I-gain (0~10 recommended)

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| I gain | I gain |

※ I gain : 0~10

e.g.) Set the runtime I gain of a wCK module with ID to 4.

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x18 | 0x04 | 0x04 | 0x78 |

• Response Packet

| 1byte | 1byte |
|---|---|
| 0x04 | 0x04 |

(14) ID Set

"ID Set" command sets the ID number of a wCK module.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x0C

Data3 = new ID(0~254)

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| new ID | new ID |

※ new ID : 0~254

e.g.) Set the ID of a wCK module with ID 0 to 30.

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x0C | 0x1E | 0x1E | 0x6C |

• Response Packet

| 1byte | 1byte |
|---|---|
| 0x1E | 0x1E |

(15) Speed Set

"Speed Set" command sets the speed and acceleration range of a wCK module.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x0D

Data3 = Speed(0~30)

Data4 = Accel(20~100), Accel = acceleration range

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| new speed | new accel |

※ new speed : 0~30, new accel : 20 ~ 100

e.g.) Set the speed and acceleration range of a wCK module with ID 0 (Speed = 30, Accel = 100).

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x0D | 0x1E | 0x64 | 0x1D |

• Response Packet

| 1byte | 1byte |
|---|---|
| 0x1E | 0x64 |

(16) Speed Read

"Speed Read" command makes a wCK module to read values of its speed and acceleration range.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x0E

Data3 = Arbitrary Value

Data4 = Arbitrary Value

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| Speed | Accel |

※ speed : 0~30, accel : 20 ~ 100

e.g.) Command a wCK module with ID 0 to read its speed and acceleration range.

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x0E | 0x00 | 0x00 | 0x6E |

• Response Packet

| 1byte | 1byte |
|---|---|
| Speed | Accel |

(17) Runtime Speed Set

"Runtime Speed Set" command sets the runtime speed and acceleration range of a wCK module.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x17

Data3 = Speed(0~30)

Data4 = Accel(20~100)

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet None

e.g.) Set the runtime speed and acceleration range of a wCK module with ID 0 (Speed = 30, Accel = 100).

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x17 | 0x1E | 0x64 | 0x0D |

• Response Packet None

(18) Over Load Set

"Over Load Set" command sets the over load boundary of a wCK module.

(※ caution : If a wCK module detect over load status, it automatically turns into Passive wCK mode.)

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x0F

Data3 = 33~199

| No | Data3 | Current(mA) |
|---|---|---|
| 1 | 33 | 400 |
| 2 | 44 | 500 |
| 3 | 56 | 600 |

| | | |
|---|---|---|
| 4 | 68 | 700 |
| 5 | 80 | 800 |
| 6 | 92 | 900 |
| 7 | 104 | 1000 |
| 8 | 116 | 1100 |
| 9 | 128 | 1200 |
| 10 | 199 | 1800 |

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| new overload | new overload |

※ new overload : 33~199

e.g.) Set the over load of a wCK module with ID 0 to 104(actual current is 1000mA).

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x0F | 0x68 | 0x68 | 0x6F |

• Response Packet

| 1byte | 1byte |
|---|---|
| 0x68 | 0x68 |

(19) Over Load Read

"Over Load Read" command makes a wCK module to read the value of its over load boundary.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x10

Data3 = Arbitrary Value

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| overload | overload |

※ overload : 33~199

e.g.) Command a wCK module with ID 0 to read its over load.

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x10 | 0x00 | 0x00 | 0x70 |

• Response Packet

| 1byte | 1byte |
|---|---|
| Over Load | Over Load |

(20) Boundary Set

"Boundary Set" command sets the rotation movement boundary of a wCK module.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x11

Data3 = new Lower Boundary(0~254)

Data4 = new Upper Boundary(0~254)

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| New Lower Boundary | New Upper Boundary |

※ new Upper Boundary : 0~254, new Lower Boundary : 0~254

e.g.) Set the movement boundary of a wCK module with ID 0 (Lower Boundary = 100, Upper Boundary = 50).

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x11 | 0x64 | 0x32 | 0x20 |

• Response Packet

| 1byte | 1byte |
|---|---|
| 0x64 | 0x32 |

(21) Boundary Read

'Boundary Read" command make a wCK module to read the value of its movement boundary.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x12

Data3 = Arbitrary Value

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| Lower Bound | Upper Bound |

※ new Upper Boundary : 0~254, new Lower Boundary : 0~254

e.g.) Comand a wCK module with ID 0 to read its boundary values.

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x12 | 0x00 | 0x00 | 0x72 |

• Response Packet

| 1byte | 1byte |
|---|---|
| Lower Boundary | Upper Boundary |

### A-1-3 Extended Command

(22) I/O Write

"I/O Write" command makes a wCK module to write to the D/O(Digital Output) port.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x64

Data3

| Arbitrary Value | | | | | | CH | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ bit0 = D/O 1 output value, bit1 = D/O 2 output value

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| D/O Value | D/O Value |

※ D/O Value = Data3

e.g.) Command a wCK module with ID 0 to write the D/O values (CH1 = 1, CH2 = 1).

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x64 | 0x03 | 0x03 | 0x04 |

• Response Packet

| 1byte | 1byte |
|---|---|
| 0x03 | 0x03 |

(23) I/O Read

"I/O Read" command make a wCK module to read the I/O data from external port.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x65

Data3 = Arbitrary Value

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1 byte | 1 byte |
|---|---|
| D/O Value | 8bit AD |

※ D/O Value structure

| Arbitrary Value | | | | | | CH | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

e.g.) Command a wCK module with ID 0 to read its I/O data.

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x65 | 0x00 | 0x00 | 0x04 |

• Response Packet

| 1byte | 1byte |
|---|---|
| Output Value | 8bit AD |

(24) Motion Data Write

"Motion Data Write" command is used to set a self-running motion program to a wCK module. Refer to [3-11 Self-running Motion] for programming logics.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|---|---|
| Header | Data1 | Data2 | Motion Count | . . . | Motion command X | Motion Data X | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x 96

Motion Count = 0 ~ 8

Motion command X = 0 ~ 254

Motion data X = 0 ~ 254

Checksum = (byte2 XOR byte3 XOR · · · byten) AND 0x7f

▶ Response Packet

| 1byte | 1byte |
|---|---|
| Motion Count | Motion Count |

Motion Count : 0 ~ 8

e.g.) Set a self-running motion to a wCK module with ID 0 (shuttle between position 82 and position 172).

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte | 1byte | 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x96 | 0x04 | 0x10 | 0x52 | 0x31 | 0x0A | 0x10 | 0xAC | 0x31 | 0x0a | 0x0c |

• Response Packet

| 1byte | 1byte |
|---|---|
| 0x04 | 0x04 |

(25) Motion Data Read

"Motion Data Read" command make a wCK module to read the number of instruction lines of a self-running motion program.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1 =

| Mode(=7) | | | ID | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7, ID : 0~30

Data2 = 0x 97

Data3 = Arbitrary Value

Data4 = Data3

Checksum = (Data1 XOR Data2 XOR Data3 XOR Data4) AND 0x7F

▶ Response Packet

| 1 byte | 1 byte |
|---|---|
| Motion Count | Motion Count |

※ Motion Count : 0 ~ 8

e.g.) Command a wCK module with ID 0 to read the line number of instructions.

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0x97 | 0x00 | 0x00 | 0x77 |

• Response Packet

| 1byte | 1byte |
|---|---|
| Motion Count | Motion Count |

### A-1-4 10 bit Command

(26) Position Move

Under high resolution mode, "Position Move" command makes wCK module return the value of current position to controller and then move to a specified target position.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Data5 | Data6 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | Arbitrary Value | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7

Data2 = 0xc8

Data3 = ID(0~253)

Data4 = Torque(0~254)

Data5 = target position(Upper(H3) 3 bit)

| X | | | | | Position(H3) | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

Data6 = target position(Lower(L7) 7 bit)

| Position(L7) | | | | | | | X |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

Check sum = (byte2 XOR byte3 XOR byte4XOR byte5 XOR byte6 XOR byte7) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| Position(H3) | Position(L7) |

※ Position(H3) + Position(L7) : 0~1023

e.g.) Command a wCK module with ID 0 to move to position 1000 at torque 0.

• Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0xC8 | 0x00 | 0x00 | 0x07 | 0xD0 | 0x7F |

• Response Packet

| 1byte | 1byte |
|---|---|
| 0x07 | 0xD0 |

(27) Position Read

Under high resolution mode, "Position Read" command makes a wCK module to read the value of its current position.

▶ Command Packet

| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| Header | Data1 | Data2 | Data3 | Data4 | Checksum |

Header = 0xFF

Data1

| Mode(=7) | | | Arbitrary Value | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

※ Mode : 7

Data2 = 0xc9

Data3 = ID(0~253)

Data4 = Data3

Check sum = (byte2 XOR byte3 XOR byte5) AND 0x7F

▶ Response Packet

| 1byte | 1byte |
|---|---|
| Position(H3) | Position(L7) |

※ Position(H3) + Position(L7) : 0~1023

e.g.) Command a wCK module with ID 0 to read its position.

• Command Packet

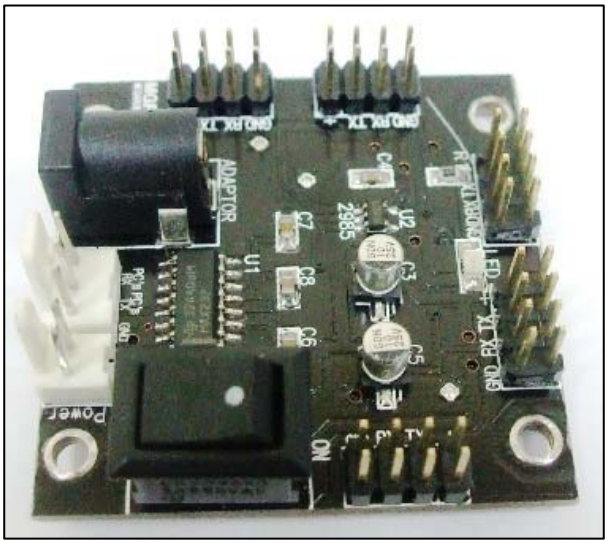
| 1byte | 1byte | 1byte | 1byte | 1byte | 1byte |
|---|---|---|---|---|---|
| 0xFF | 0xE0 | 0xC9 | 0x00 | 0x00 | 0x29 |

• Response Packet

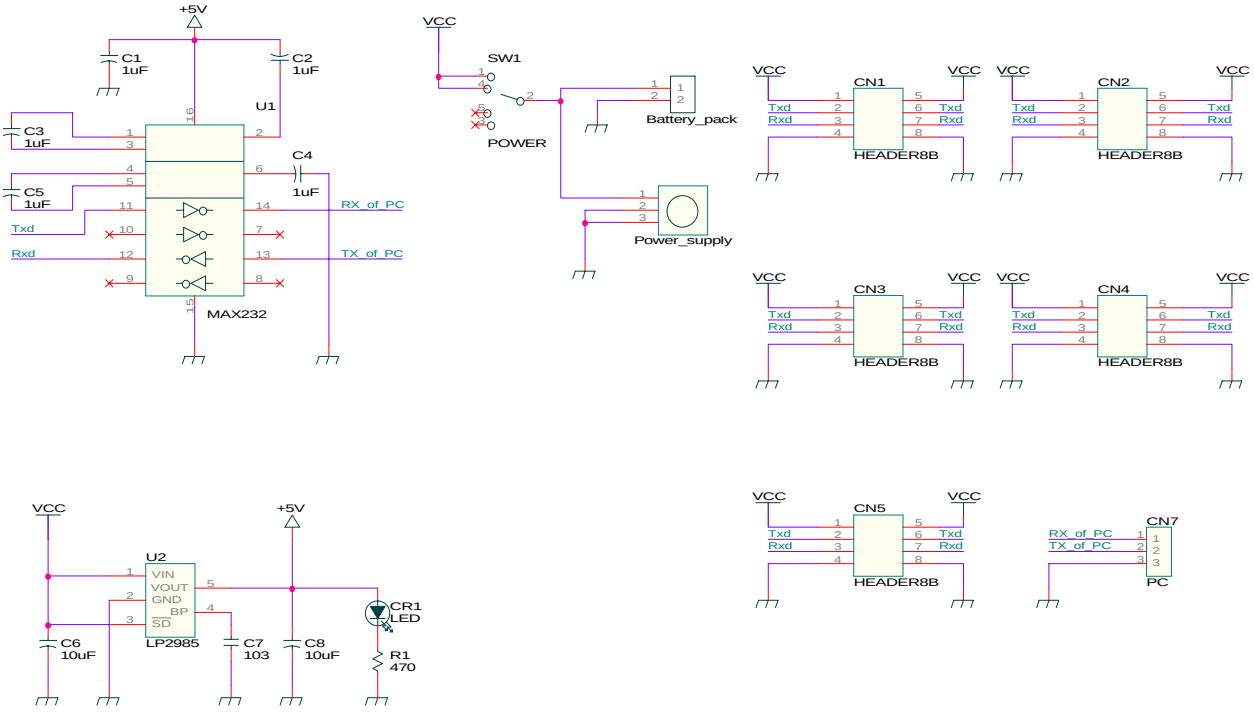
| 1byte | 1byte |
|---|---|
| Position(H3) | Position(L7) |

## A-2 Communication Signal Adjustment Circuit Board

RS-232 communication signal adjustment circuit board is used to adjust the signal level between wCK module and a controller. The following are the picture and circuit diagram of the signal board.




[Figure A-2a] RS-232 Communication Signal Adjustment Circuit Board




[Figure A-2b] Circuit Diagram of Communication Board

## A-3 Baud rate setting for Independent Controller

In case of using a MCU to control a wCK module, it's recommended that a user refer to the following information in tables to minimize communication error.

●MCS51 family(using Timer 1 , Mode 1)

| Clock[Mhz] | SMOD | TH1 | Baud Rate[bps] | Error[%] |
|---|---|---|---|---|
| 7.3728 | 0 | 252 | 4800 | 0 |
| 7.3728 | 1 | 248 | 4800 | 0 |
| 7.3728 | 0 | 254 | 9600 | 0 |
| 7.3728 | 1 | 252 | 9600 | 0 |
| 7.3728 | 1 | 255 | 38400 | 0 |
| 11.0592 | 0 | 250 | 4800 | 0 |
| 11.0592 | 1 | 244 | 4800 | 0 |
| 11.0592 | 0 | 253 | 9600 | 0 |
| 11.0592 | 1 | 250 | 9600 | 0 |
| 11.0592 | 1 | 255 | 57600 | 0 |
| 14.7456 | 0 | 248 | 4800 | 0 |
| 14.7456 | 1 | 240 | 4800 | 0 |
| 14.7456 | 0 | 252 | 9600 | 0 |
| 14.7456 | 1 | 248 | 9600 | 0 |
| 14.7456 | 0 | 255 | 38400 | 0 |
| 14.7456 | 1 | 254 | 38400 | 0 |
| 22.1184 | 0 | 244 | 4800 | 0 |
| 22.1184 | 1 | 232 | 4800 | 0 |
| 22.1184 | 0 | 250 | 9600 | 0 |
| 22.1184 | 1 | 244 | 9600 | 0 |
| 22.1184 | 1 | 253 | 38400 | 0 |
| 22.1184 | 0 | 255 | 57600 | 0 |
| 22.1184 | 1 | 254 | 57600 | 0 |
| 22.1184 | 1 | 255 | 115200 | 0 |

●80c196Kx(Mode1)

| Clock[Mhz] | SP_BAUD | Baud Rate[bps] | Error[%] |
|---|---|---|---|
| 7.3728 | 805F | 4800 | 0 |
| 7.3728 | 802F | 9600 | 0 |
| 7.3728 | 800B | 38400 | 0 |
| 7.3728 | 8007 | 57600 | 0 |
| 7.3728 | 8003 | 115200 | 0 |
| 11.0592 | 808F | 4800 | 0 |
| 11.0592 | 8047 | 9600 | 0 |
| 11.0592 | 8011 | 38400 | 0 |
| 11.0592 | 800B | 57600 | 0 |
| 11.0592 | 8005 | 115200 | 0 |
| 14.7456 | 80BF | 4800 | 0 |
| 14.7456 | 805F | 9600 | 0 |
| 14.7456 | 8017 | 38400 | 0 |
| 14.7456 | 800F | 57600 | 0 |

| | | | |
|---|---|---|---|
| 14.7456 | 8007 | 115200 | 0 |
| 14.7456 | 8003 | 230400 | 0 |

●PIC family

| Clock[Mhz] | BRGH | SPBRG | Baud Rate[bps] | Error[%] |
|---|---|---|---|---|
| 3.6864 | 0 | 11 | 4800 | 0 |
| 3.6864 | 0 | 5 | 9600 | 0 |
| 3.6864 | 0 | 0 | 57600 | 0 |
| 7.3728 | 0 | 23 | 4800 | 0 |
| 7.3728 | 0 | 11 | 9600 | 0 |
| 7.3728 | 0 | 2 | 38400 | 0 |
| 7.3728 | 0 | 1 | 57600 | 0 |
| 7.3728 | 0 | 0 | 115200 | 0 |
| 11.0592 | 0 | 35 | 4800 | 0 |
| 11.0592 | 0 | 17 | 9600 | 0 |
| 11.0592 | 0 | 2 | 57600 | 0 |
| 14.7456 | 0 | 47 | 4800 | 0 |
| 14.7456 | 0 | 5 | 38400 | 0 |
| 14.7456 | 0 | 3 | 57600 | 0 |
| 14.7456 | 0 | 1 | 115200 | 0 |

●AVR family

| Clock[Mhz] | UBRRH | UBRRL | Baud Rate[bps] | Error[%] |
|---|---|---|---|---|
| 7.3728 | 0 | 95 | 4800 | 0 |
| 7.3728 | 0 | 47 | 9600 | 0 |
| 7.3728 | 0 | 11 | 38400 | 0 |
| 7.3728 | 0 | 7 | 57600 | 0 |
| 7.3728 | 0 | 3 | 115200 | 0 |
| 7.3728 | 0 | 0 | 460800 | 0 |
| 14.7456 | 0 | 383 | 2400 | 0 |
| 14.7456 | 0 | 191 | 4800 | 0 |
| 14.7456 | 0 | 95 | 9600 | 0 |
| 14.7456 | 0 | 23 | 38400 | 0 |
| 14.7456 | 0 | 15 | 57600 | 0 |
| 14.7456 | 0 | 7 | 115200 | 0 |
| 14.7456 | 0 | 2 | 230400 | 0 |
| 14.7456 | 0 | 1 | 460800 | 0 |
| 14.7456 | 0 | 0 | 921600 | 0 |

## A-4 Application Example

The following is an example C programs required and helpful for controlling a wCK module. Functions relating to serial communication may vary depending upon the type of MPU so add accordingly required functions for your MPU.

```
/*============================================================================*/
/* Example Program                                                            */
/* Motion Explanation : If given a force, wCK rotates to the direction of the force and stops  */
/* Motion Logic : Read wCK's position feedback to decide rotation direction and start movement */
/*                when there's any change in position                         */
/*============================================================================*/
#define HEADER    0xff
#define NULL      0
#define ROTATE_CCW  3
#define ROTATE_CW  4

/* Start of Function Prototype-------------------------------------------------*/
/*---------------- Function relating to serial communication ----------------*/
void SendByte(char data);   // Send 1 Byte to serial port
void GetByte(char timeout); // Receive 1 Byte from serial port
/*----------------Basic Functions relating to wCK module-----------------------*/
void SendOperCommand(char Data1, char Data2);
void SendSetCommand(char Data1, char Data2, char Data3, char Data4);
char PosSend(char ServoID, char SpeedLevel, char Position);
char PosRead(char ServoID);
char ActDown(char ServoID);
char PowerDown(void);
char Rotation360(char ServoID, char SpeedLevel, char RotationDir);
void SyncPosSend(char LastID, char SpeedLevel, char *TargetArray, char Index);
char BaudrateSet(char ServoID, char NewBaud);
char GainSet(char ServoID, char *NewPgain, char *NewDgain);
char IdSet(char ServoID, char NewId);
char GainRead(char ServoID, char *Pgain, char *Dgain);
char ResolSet(char ServoID, char NewResol);
char ResolRead(char ServoID);
char OverCTSet(char ServoID, char NewOverCT);
char OverCTRead(char ServoID);
char BoundSet(char ServoID, char *NewLBound, char *NewUBound);
char BoundRead(char ServoID, char *LBound, char *UBound);
/*------------------------------------------------- End of Function Prototype */
```

```
void main(void)
{
  char i, old_position;

  Initialize();  // Initialize peripheral devices(prepare for serial port)

  id = 0;
  old_position = ActDown(id);   // Read the initial position of a wCK with ID 0
  while(1) {
    now_position = ActDown(id);  // Read current position
    // If position value decreased, rotate to ccw direction for 1 second and turn to passive mode for 1 second
    if(now_position<old_position) {
      Rotation360(id, 10, ROTATE_CCW);
      delay_ms(1000);
      ActDown(id);
      delay_ms(1000);
    }
    // If position value increased, rotate to cw direction for 1 second and turn to passive mode for 1 second
    else if(now_position>old_position) {
      Rotation360(id, 10, ROTATE_CW);
      delay_ms(1000);
      ActDown(id);
      delay_ms(1000);
    }
    old_position = ActDown(id); // Read current position and save it
    delay_ms(300);
  }
}

//////////////////////////////// Definition of Basic Functions ////////////////////////
/*************************************************************************************/
/* Function that sends Operation Command Packet(4 Byte) to wCK module */
/* Input : Data1, Data2                                               */
/* Output : None                                                      */
/*************************************************************************************/
void SendOperCommand(char Data1, char Data2)
{
  char CheckSum;
  CheckSum = (Data1^Data2)&0x7f;
  SendByte(HEADER);
  SendByte(Data1);
  SendByte(Data2);
  SendByte(CheckSum);
```

```
}

/*****************************************************************************/
/* Function that sends Set Command Packet(6 Byte) to wCK module     */
/* Input : Data1, Data2, Data3, Data4                                */
/* Output : None                                                     */
/*****************************************************************************/
void SendSetCommand(char Data1, char Data2, char Data3, char Data4)
{
  char CheckSum;
  CheckSum = (Data1^Data2^Data3^Data4)&0x7f;
  SendByte(HEADER);
  SendByte(Data1);
  SendByte(Data2);
  SendByte(Data3);
  SendByte(Data4);
  SendByte(CheckSum);
}

/*****************************************************************************************************/
/* Function that sends Position Move Command to wCK module          */
/* Input : ServoID, SpeedLevel, Position                             */
/* Output : Current                                                  */
/*****************************************************************************************************/
char PosSend(char ServoID, char SpeedLevel, char Position)
{
  char Current;
  SendOperCommand((SpeedLevel<<5)|ServoID, Position);
  GetByte(TIME_OUT1);
  Current = GetByte(TIME_OUT1);
  return Current;
}


/*****************************************************************************************************/
/* Function that sends Position Read Command to wCK module          */
/* Input : ServoID                                                   */
/* Output : Position                                                 */
/*****************************************************************************************************/
char PosRead(char ServoID)
{
  char Position;
  SendOperCommand(0xa0|ServoID, NULL);
```

```
  GetByte(TIME_OUT1);
  Position = GetByte(TIME_OUT1);
  return Position;
}

/*************************************************************************/
/* Function that sends Passive wCK Command to wCK module          */
/* Input : ServoID                                                 */
/* Output : Position                                               */
/*************************************************************************/
char ActDown(char ServoID)
{
  char Position;
  SendOperCommand(0xc0|ServoID, 0x10);
  GetByte(TIME_OUT1);
  Position = GetByte(TIME_OUT1);
  return Position;
}

/*************************************************************************/
/* Function that sends Break  wCK Command to wCK module           */
/* Input : None                                                    */
/* Output : ServoID if succeed, 0xff if fail                       */
/*************************************************************************/
char PowerDown(void)
{
  char ServoID;
  SendOperCommand(0xdf, 0x20);
  ServoID = GetByte(TIME_OUT1);
  GetByte(TIME_OUT1);
  if(ServoID<31) return ServoID;
  return 0xff;    //Receive error
}

/*********************************************************************/
/* Function that sends 360 degree Wheel wCK Command      */
/* Input : ServoID, SpeedLevel, RotationDir              */
/* Return : Rotation Number                              */
/*********************************************************************/
char Rotation360(char ServoID, char SpeedLevel, char RotationDir)
{
  char ServoPos, RotNum;
  if(RotationDir==ROTATE_CCW) {
```

```
    SendOperCommand((6<<5)|ServoID, (ROTATE_CCW<<4)|SpeedLevel);
  }
  else if(RotationDir==ROTATE_CW) {
    SendOperCommand((6<<5)|ServoID, (ROTATE_CW<<4)|SpeedLevel);
  }
  RotNum = GetByte(TIME_OUT1);
  GetByte(TIME_OUT1);
  return RotNum;
}


/*****************************************************************************/
/* Function that sends Synchronized Position Move Command to wCK module     */
/* Input : LastID, SpeedLevel, *TargetArray, Index                           */
/* Return : None                                                             */
/*****************************************************************************/
void SyncPosSend(char LastID, char SpeedLevel, char *TargetArray, char Index)
{
  int i;
  char CheckSum;
  i = 0;
  CheckSum = 0;
  SendByte(HEADER);
  SendByte((SpeedLevel<<5)|0x1f);
  SendByte(LastID+1);
  while(1) {
    if(i>LastID) break;
    SendByte(TargetArray[Index*(LastID+1)+i]);
    CheckSum = CheckSum ^ TargetArray[Index*(LastID+1)+i];
    i++;
  }
  CheckSum = CheckSum & 0x7f;
  SendByte(CheckSum);
}

/*****************************************************************/
/* Function that sends Baud rate Set Command to wCK module       */
/* Input : ServoID, NewBaud                                      */
/* Return : New Baudrate if succeed, 0xff if fail                */
/*****************************************************************/
char BaudrateSet(char ServoID, char NewBaud)
{
  SendSetCommand((7<<5)|ServoID, 0x08, NewBaud, NewBaud);
```

```
  GetByte(TIME_OUT2);
  if(GetByte(TIME_OUT2)==NewBaud) return NewBaud;
  return 0xff;
}

/*********************************************************************/
/* Function that sends Gain Set Command to wCK module    */
/* Input : ServoID, *NewPgain, *NewDgain                 */
/* Return : 1 if succeed, 0 if fail                      */
/*********************************************************************/
char GainSet(char ServoID, char *NewPgain, char *NewDgain)
{
  char Data1,Data2;
  SendSetCommand((7<<5)|ServoID, 0x09, *NewPgain, *NewDgain);
  Data1 = GetByte(TIME_OUT2);
  Data2 = GetByte(TIME_OUT2);
  if((Data1==*NewPgain) && (Data2==*NewDgain)) return 1;
  return 0;
}


/*************************************************************/
/* Function that sends ID Set Command to wCK module      */
/* Input : ServoID, NewId                                */
/* Return : New ID if succeed, 0xff if fail              */
/*************************************************************/
char IdSet(char ServoID, char NewId)
{
  SendSetCommand((7<<5)|ServoID, 0x0a, NewId, NewId);
  GetByte(TIME_OUT2);
  if(GetByte(TIME_OUT2)==NewId) return NewId;
  return 0xff;
}

/*********************************************************************/
/* Function that sends Gain Read Command to wCK module  */
/* Input : ServoID, *NewPgain, *NewDgain                 */
/* Return : 1 if succeed,  0 if fail                     */
/*********************************************************************/
char GainRead(char ServoID, char *Pgain, char *Dgain)
{
  SendSetCommand((7<<5)|ServoID, 0x0c, 0, 0);
  *Pgain = GetByte(TIME_OUT1);
```

```
  *Dgain = GetByte(TIME_OUT1);
  if((*Pgain>0) && (*Pgain<51) && (*Dgain<101)) return 1;
  return 0;
}

/*****************************************************************************/
/* Function that sends Over Load Set Command to wCK module          */
/* Input : ServoID, NewOverCT                                        */
/* Return : New Overcurrent Threshold if succeed, 0xff if fail       */
/*****************************************************************************/
char OverCTSet(char ServoID, char NewOverCT)
{
  char Data1;
  SendSetCommand((7<<5)|ServoID, 0x0f, NewOverCT, NewOverCT);
  sciRxReady(TIME_OUT2);
  Data1=sciRxReady(TIME_OUT2);
  if(Data1!=0xff) return Data1;
  return 0xff;
}

/*****************************************************************************/
/* Function that sends Over Load Read Command to wCK module          */
/* Input : ServoID                                                   */
/* Return : Overcurrent Threshold if succeed, 0xff if fail           */
/*****************************************************************************/
char OverCTRead(char ServoID)
{
  char Data1;
  SendSetCommand((7<<5)|ServoID, 0x10, 0, 0);
  sciRxReady(TIME_OUT1);
  Data1=sciRxReady(TIME_OUT1);
  if(Data1!=0xff) return Data1;
  return 0xff;
}

/*****************************************************************************/
/* Function that sends Boundary Set Command to wCK module            */
/* Input : ServoID, *NewLBound, *NewUBound                           */
/* Return : 1 if succeed, 0 if fail                                  */
/*****************************************************************************/
char BoundSet(char ServoID, char *NewLBound, char *NewUBound)
{
  char Data1,Data2;
```

```
  SendSetCommand((7<<5)|ServoID, 0x11, *NewLBound, *NewUBound);
  Data1 = GetByte(TIME_OUT2);
  Data2 = GetByte(TIME_OUT2);
  if((Data1==*NewLBound) && (Data2==*NewUBound)) return 1;
  return 0;
}

/*************************************************************************/
/* Function that sends Boundary Read Command to wCK module              */
/* Input : ServoID, *NewLBound, *NewUBound                               */
/* Return :  1 if succeed, 0 if fail                                     */
/*************************************************************************/
char BoundRead(char ServoID, char *LBound, char *UBound)
{
  SendSetCommand((7<<5)|ServoID, 0x12, 0, 0);
  *LBound = GetByte(TIME_OUT1);
  *UBound = GetByte(TIME_OUT1);
  if(*LBound<*UBound) return 1;
  return 0;
}
////////////////////////////// End of Basic Functions Definition //////////////////////////
```

## A-5 Default Parameter Settings

- Baud Rate 7 (115,200 bps)
- P gain 20
- D gain 30
- I gain 0
- wCK module ID 0
- Movement Speed 0 (No speed limit)
- Acceleration Range 60
- Over-current 33 (400mA)
- Control Angle Range 1, 254 (1~254)
- Motion Program Writing 0 (Self-running Motion inactivated)

## ■ wCK protocol definition

| Command | | Command Packet byte 1 | byte 2 (7 6 5 4 3 2 1 0) | byte 3 (7 6 5 4 3 2 1 0) | byte 4 (7 6 5 4 3 2 1 0) | byte 5 (7 6 5 4 3 2 1 0) | byte 6 (7 6 5 4 3 2 1 0) | byte 7 (7 6 5 4 3 2 1 0) | byte 8 (7 6 5 4 3 2 1 0) | byte 9 (7 6 5 4 3 2 1 0) | byte 10 (7 6 5 4 3 2 1 0) | … | byte (7 6 5 4 3 2 1 0) | byte (7 6 5 4 3 2 1 0) | byte | Response Packet byte 1 (7 6 5 4 3 2 1 0) | byte 2 (7 6 5 4 3 2 1 0) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8bit Command | Position Move | header | Torq | ID | target position | check sum | | | | | | | | | | Load | position |
| | | 0xFF | 0~4 | 0~30 | 0~254 | (note1) | | | | | | | | | | 0~254 | 0~254 |
| | Syncronized Position Move | | 0~4 | 31 | X / lastID+1 | ID0 target | ID1 target | ID2 target | ID3 target | ID4 target | ID5 target | ID6 target | … | lastID−1 target | lastID target | check sum | |
| | | | | | 1~31 | 0~254 | 0~254 | 0~254 | 0~254 | 0~254 | 0~254 | 0~254 | | 0~254 | 0~254 | (note2) | |
| | Status Read | | mode | ID | X | check sum | | | | | | | | | | Load | position |
| | | | 5 | 0~30 | | | | | | | | | | | | 0~254 | 0~254 |
| | Passive wCK | | 6 | ID | mode / X | | | | | | | | | | | byte3 | position |
| | | | | 0~30 | 1 | | | | | | | | | | | | 0~254 |
| | Wheel wCK | | | | 3=CCW 4=CW / speed | | | | | | | | | | | Rotation Count | position |
| | | | | | 0~15 | (note1) | | | | | | | | | | | 0~254 |
| | Break wCK | | | 31 | 2 / X | | | | | | | | | | | ID | position |
| | | | | | | | | | | | | | | | | | 0~254 |
| Configure Command | Baudrate Set | | 7 | ID | mode | new baudrate | = byte4 | check sum | | | | | | | | new baudrate | new baudrate |
| | | | | 0~30 | 8 | 0~191 | | (note3) | | | | | | | | | |
| | P,D gain Set | | | | 9 | new P gain | new D gain | | | | | | | | | new P gain | new D gain |
| | | | | | | 1~254 | 0~254 | | | | | | | | | | |
| | P,D gain Read | | | | 10 | X | = byte4 | | | | | | | | | P gain | D gain |
| | Runtime P,D gain Set | | | | 11 | P gain | D gain | | | | | | | | | P gain | D gain |
| | | | | | | 1~254 | 0~254 | | | | | | | | | | |
| | ID Set | | | | 12 | new ID | = byte4 | | | | | | | | | new ID | new ID |
| | | | | | | 0~254 | | | | | | | | | | | |
| | SPEED Set | | | | 13 | speed | accel | | | | | | | | | new Speed | new Accel |
| | | | | | | 0~30 | 20~100 | | | | | | | | | | |
| | SPEED Read | | | | 14 | X | = byte4 | | | | | | | | | Speed | Accel |
| | Over Load Set | | | | 15 | new overcur T | = byte4 | | | | | | | | | new Over Load | new Over Load |
| | | | | | | 33~199 | | | | | | | | | | | |
| | Over Load Read | | | | 16 | X | = byte4 | | | | | | | | | Over Load | Over Load |
| | Boundary Set | | | | 17 | new L bound | new U bound | | | | | | | | | new L bound | new U bound |
| | | | | | | 0~254 | 0~254 | | | | | | | | | | |
| | Boundary Read | | | | 18 | X | = byte4 | | | | | | | | | L bound | U bound |
| | I gain Set | | | | 21 | new I gain | =byte4 | | | | | | | | | new I gain | new I gain |
| | | | | | | 0~10 | | | | | | | | | | | |
| | I gain Read | | | | 22 | X | =byte4 | | | | | | | | | I gain | I gain |
| | Runtime Speed Set | | | | 23 | speed | accel | | | | | | | | | | |
| | | | | | | 0~30 | 20~100 | | | | | | | | | | |
| | Runtime I gain Set | | | | 24 | I gain | I gain | | | | | | | | | P gain | D gain |
| | | | | | | 0~10 | 0~10 | | | | | | | | | | |
| Extended Command | I/O Write | | | | 100 | X / ch | =byte4 | check sum | | | | | | | | D/O Value | D/O Value |
| | | | | | | | | | | | | | | | | | |
| | I/O Read | | | | 101 | X | =byte4 | | | | | | | | | D/O Value | 8bit AD |
| | Motion DATA Write | | | | 150 | Motion Count | Motion Command 1 | Motion DATA 1 | Motion Command 2 | Motion DATA 2 | Motion Command 3 | Motion DATA 3 | … | | check sum | Motion Count | Motion Count |
| | | | | | | 0~8 | 0~254 | 0~254 | 0~254 | 0~254 | 0~254 | 0~254 | | | (note4) | 0~8 | 0~8 |
| | Motion DATA Read | | | | 151 | X | =byte4 | check sum | | | | | | | | Motion Count | Motion Count |
| | | | | | | | | (note3) | | | | | | | | 0~8 | 0~8 |
| 10bit Command | Position Move | | | x | 200 | ID | Torq | target(H3) | target(L7) / X | check sum | | | | | | position(H3) | position(L7) / X |
| | | | | | | 0~253 | 0~254 | 0~1023 | | (note6) | | | | | | 0~1023 | |
| | Position Read | | | | 201 | ID | =byte4 | check sum | | | | | | | | position(H3) | position(L7) / X |
| | | | | | | 0~253 | | (note5) | | | | | | | | 0~1023 | |

※ X : don't care
※ note1 : CheckSum = (byte2 XOR byte3) AND 0x7F
※ note2 : CheckSum = (byte4 XOR … (byte(lastID+3)) AND 0x7F
※ note3 : CheckSum = (byte2 XOR byte3 XOR byte4 XOR byte5) AND 0x7F
※ note4 : CheckSum = (byte2 XOR byte3 XOR … byteN) AND 0x7F
※ note5 : CheckSum = (byte2 XOR byte3 XOR … byteN) AND 0x7F
※ note6 : CheckSum = (byte2 XOR byte3 XOR byte4 XOR byte5 XOR byte6 XOR byte7) AND 0x7F
※ Motion DATA commands: Self-running motion mode is activated only when the No of Instruction is more than 0 .